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TRACTION.

IT is proverbial that small beginnings have great endings. It has been the fault of electrical companies to be born great and to get smaller by degrees and beautifully less, until the vanishing point in many instances was reached. It is a fact that the public generally have not rushed frantically after the shares which have been from time to time offered them. They are wise in their generation, because in too many cases the companies have been promoted not so much in the public interest as to recoup some person or persons their outlay on experimental trials, plus an extremely handsome margin to cover interest and goodwill. The exhorbitant gains sought have done much to deter the multitude from supporting electrical concerns, and a heavy weight of dead capital must for ever cripple their dividend earning power per cent. The enormous sum asked for the Thomson welding patents in this country has been severely animadverted upon in the press, and if rumour for once speaks correctly, it will probably soon be heard uttering similar sentiments in connection with electric traction.

We are extremely sorry for this. Electric traction bids fair to be, and can hardly fail to be before long, a most, if not the most, popular branch of electrical engineering. There is a real demand for it. The tramway companies are looking to it, the poor ones as their salvation, the successful as an aid to larger profits. The details have been so threshed out in various directions that when it does boom it should not be a short-lived torrent, but a steady running river, widening and deepening with its advance.

The more the varieties of systems the merrier; let them all have a trial; the fittest will survive. Perhaps we should not expect human nature to get less than it can, but there is a vaulting ambition which overreaches itself, and with the knowledge which is in the possession of those who have studied the question, watched its development, and collated the data at disposal, to vaunt any one particular so-called system at the expense of others, to attempt to foist it on the electrically uneducated as the one and only, of enormous money value as a system apart from goods supplied and work done, is to court a fall on the other side.

There are really only three systems, and of these there may be many variations, each having special merits and suitabilities to varying conditions and circumstances. When covered by patents in all or any of its parts, each variety has its money value by reason of the fact that no one else can apply it. Its value depends upon its exclusive applicability to some large field. Taking one system only as being admittedly that suitable to operation in crowded thoroughfares, or, in other words, where most traffic receipts are available—that by batteries; and ignoring the use of primary batteries as not of commercial value for the purpose, at any rate at present, we have to consider what it is which, in an appeal to the public for purchase money, there is to sell.

There is no patent in two lines of rails nor in a tramcar. What are patentable, and therefore may be of saleable value, are the motor, the gearing and the accumulators. There was a time when some thought that the manufacture of useful dynamos was a monopoly; but that time has long passed. The number of good dynamos is legion, and although, as a motor, it has up to now in England not commanded a large market, the time is rapidly approaching when its use will be more appreciated and general, and there will be no lack of good motors. Seeing that they can be obtained with as high an efficiency as some 90 per cent., there is not much scope for improvement, and the value of any particular make to its manufacturers lies only in the price at which it can be produced and sold. To ask large sums for a motor patent should be as futile as to expect the same for the patent of a dynamo. With the gearing it is somewhat different. Extraordinary as it may appear, it is the non-electrical and purely mechanical portion of

the electric car which has given the most trouble, and constituted its weakest part. How many gearings are there which are patented or susceptible of being patented? There remains the accumulator. So far, the E.P.S. is the only one which in this country, after much use, has proved itself capable. We hope, in the interests of electric traction, and believe, that the time is approaching when something lighter and less subject to deterioration will be found, but we can only deal with facts as they are, and accept what has been proved.

In view of the foregoing, we are led to say that no project has a right to ask a large amount by way of purchase money which does not exclusively command an exceptional gearing and an improved accumulator, both of which have stood the test of actual working over a lengthened period, or else something very remarkable in the way of goodwill or concession. Nothing we more desire to see than a healthy development of electric traction, whatever its system and whoever its promoters. We are convinced that electricity for tramway purposes is the motive power of the future, as it has been long alluded to as the light, and will perhaps some day be styled the heat, of the future. Let us all hasten its adoption by every means in our power which are honest and straight-forward, and support it as far as we are able, while inducing others to support, every well-digested and practical scheme. But let us, at all hazards, decry every attempt to extort purchase-money from the ill-informed and unwary for that which has not intrinsic worth. What injury was done to electric lighting by the inflation and collapse of its early companies? We are only just recovering from that shock, and do not want history to repeat itself in traction. The monetary department of electrical traction should follow an electrical law.

$$C = \frac{v}{R}$$

where C, the capital subscribed, depends upon the relation of v veracity (somebody here suggested voracity), and R the resistance of the public to a new idea; and remember that whatever the efficiency of promotors they do not give out all they absorb. There is no gambling mania on just now in electrical properties, and little probability of wild-cat schemes obtaining favour, or salted projects going at high prices. In due time traction companies must be formed; let us hope they will be all unexceptionable.

A rumour is in the air that it is proposed to float a company asking somewhere between, perhaps, a quarter and half a million sterling, two-thirds to go into the pockets of its parents and guardians. With the fatal effects which a smothering of electrical companies in their own fully-paid shares had upon so many concerns within our view, we cannot but look upon the advent of another such mistake, in the line of traction, without grave misgivings as to what effect it will have upon the confidence of the public, and upon the chance of obtaining money for electric traction in future. If small business firms were to start exploiting any new idea, and having spent their money on experiments, most of which were failures, were to ask a private person to give them back all their money, and pay them well in addition for the mistakes they had made, they would find that private person hardly soft enough to be squeezed in such a manner; and if they did, indeed, come across such an individual and bleed him, unpleasant proceedings might follow. We cannot think that men of good repute and wealth, even to save themselves from severe loss, will attempt to foist that loss on the parson and the widow.

Adventurers have to take the chance. If their adventures lead to success, they expect and receive the reward of success. Their deserts, however, should be in proportion to what they have achieved, and success in such a matter means profit earned. It does no good to anyone but to the immediate beneficiares, and does positive harm all round, except to them, when exhorbitant sums are taken for more or less valueless goodwills. To blight the fair prospects of electric traction as a new source of investment and wealth by a gigantic failure induced by greed, would be a blunder worse than a crime.

Electric Traction Data.

THE paper read by Mr. Reckenzaun on this subject, and of which we published the conclusion last week, was, in its way, an admirable specimen of the author's well-known ability in placing convincing figures before his hearers. What would be more entertaining, however, to the advocates of electric traction in this country would be a true statement of accounts of the defunct Elieson scheme, and the balance sheet of the working expenses and receipts of the section of line now being electrically operated at Barking. With an ideal board of directors, immaculate experts and an infallible staff of assistants, no doubt electric traction is, on paper, very much cheaper than horse motive power, but with the matter-of-fact and worldly people who have to carry out practically the operations of what manufactured statistics show to be perfect "El Dorados," the results in this country do not always tally with theoretical assertions.

Type Setting.

WE have received some fine specimens of type setting by the "Thorne" machine, and this suggests the thought that if compositors deem it advisable to stand out for fewer hours of work and increased payment, their action will give a great impetus to the use of these mechanical type setters. It is not necessary to enter into a discussion as to how this would affect the workmen in the printing trade, for the inference is obvious.

Municipal Lighting.

AS many towns will shortly be adopting electric lighting on their own account, it would be well if attention were drawn to the figures which occasionally reach us from America. In answer to enquiries made in a well-known town in the States which has been lighted by the municipal body for a few years past, it appears that electric lighting has not been so great a success as the opponents of private enterprise claim. The town authorities distinctly state that with their experience they are not in favour of cities doing their own light-

ing in consequence of political preferences and frequent changes in the management which means great expense. It further states that incompetent engineers, linemen, and trimmers are kept in place for political or other purposes, and what with poor carbons, lack of attention generally, grounding of wires, breaking of globes, infringement of patents, constant repairs, &c., the system is not only expensive, but of an unknown amount, till the working year expires. On the contract plan one pays for what one gets only, and we know what to provide for in the estimate for tax levy. In conclusion, they would not undertake the lighting of the city if it were to be done over again. This is the somewhat bitter experience of a town which has supplied its own light for a considerable period, and coming from the country of electric lighting *par excellence*, we should imagine it ought to carry some weight with those venturesome vestries who anticipate that their electric lighting schemes are easy of execution.

Electric Light in the Suez Canal.

IT is questionable whether the electric light has ever proved itself of greater advantage than in its employment by steamers traversing the Suez Canal. Consul Burrell, of Port Said, gives a full account of the progress which has been made, which fully indicates the great saving that must have resulted to steamship owners from the use of the new light. The new regulations for the use of electric light came into operation on March 1st, 1887, and since then the number of vessels travelling by night has increased remarkably. In 1887 only 395 steamers used the electric light, but in 1888 the number rose to 1,611, and in 1889 a total of 2,445 vessels so navigated the Suez Canal. Previous to the date above mentioned only mail steamers were allowed to make the night passage.

The Production of Ozone.

WITH reference to the commercial production of ozone, to which attention has been called more than once lately in the REVIEW, we desire to make mention of an account of some interesting experiments made in this direction by Messrs. Spottiswoode and Paul Ward, and published in the *English Mechanic* for September 17th, 1886.

A Theory of Accumulators.

IN our issue of April 11th, we gave an abstract from a paper read by Dr. Schoop, together with an abbreviated copy of Prof. Carhart's criticism on certain statements contained in it. We refrained from commenting upon either of these communications, and left it to our readers to form their own conclusions upon the theory and accompanying figures. Last week's American mail brought a letter from Dr. Schoop in which this gentleman complains that we had given Prof. Carhart's criticism too much prominence, and he refers us to a further communication on the same subject contained in the *Western Electrician* of May 3rd. We have carefully perused this article, but we fail to find in it experimental proofs of some of his original assertions, and we are not prepared to take for gospel all that Dr. Schoop says against the generally accepted notions concerning the chemical reactions in lead accumulators. The article is cleverly written; it teems with words, nothing but words and ambiguous sentences. Perhaps, as the author's experience advances, he may furnish a logical sequence and convince us that he is right, and everybody else wrong, in the interpretation of certain scientific facts.

Is Union Strength?

IT is said that the electric tramway section of the Thomson-Houston Company, which is here represented by Mr. W. S. Graff-Baker, is about to amalgamate with the Series Electric Traction Syndicate. If the parties to the combinations which from time to time are effected would individually endeavour to accomplish some sound work, it would be all the better for the electrical industry here. The amalgamation of firms or companies, some of which have no creditable record, seems to be the principal object in electro-technical circles, but what good comes of it? In nine cases out of ten the gigantic combination continues the career of masterly inactivity previously so well carried out by those it has gathered into its fold.

Smothering the Electric Fluid.

IN our Notes columns the description of a storm at Aston-under-Lyne will be found entertaining reading. The idea of smothering the electric fluid in an empty tank is indeed a novelty, and the correspondent of the Manchester *Courier* is to be congratulated upon his graphic pourtrayal of what must have been a harrowing scene.

Electric Traction Enterprise in America.

IMPORTANT work may be expected in electric traction in America. A week or two ago it was announced that the Westinghouse Company had resolved to enter the field and compete with the present workers. Considerable interest will be centred upon this company, as it is by no means certain what system will be adopted. Of more recent date is the formation of the United Electric Traction Company with a capital of $7,000,000. This is a consolidation of the Daft and Julien companies, both well-known in the electrical world. An exchange, commenting upon these late developments, says, "it may lead to other notable changes," and concludes an article on the subject with the remark that "the time is ripe for electric traction in New York." It is now said, however, by the manager of the Julien Company, that it is premature to include as yet the Julien Company in this new consolidation.

Electric Meters.

WHEN are we going to have a really reliable meter which will be direct reading, will not increase its records unduly as more current is passed through it, and will be fair alike to user and supplier? One at present in use certainly reads direct, but as fresh lamps are added to the circuit in which it is placed it records for some little time a greater amount of current than is actually used. Another has a constant by which the dial records have to be multiplied and, needless to say, this constant is a decimal quantity, and therefore of no use to the average British domestic. A third, again, is a mysterious box, with the contents of which the consumer stands in absolute ignorance, not unmixed with a wholesome awe which is fostered by the suppliers agents; he is told that so many hours use of the current in the house to be measured will be exactly recorded by a certain increased weight in the mysterious plate contained in the equally mystic box; in each case the customer is at the mercy of the supply company, and, to our knowledge, two users have been grossly overcharged in their accounts, and are simply told, "The meter record is conclusive evidence against an overcharge." Is it? In the supplier's eye, perhaps, in the consumer's certainly not!

ELECTRIC LIGHTING OF A RUSSIAN PALACE.

THE Russian Imperial "House Ministry" last month resolved to light all the buildings at Zarskoe-Selo, belonging to the Department of the Imperial Palaces, by electricity, and on April 5th the machines and apparatus for the erection of a central station were ordered to be supplied by the machinery works of M. Podobedoff at St. Petersburg.

The central station will, in the first place, be constructed with a capacity of 50,000 watts, and is to serve for lighting the palace, some outbuildings, and the hospital. For this purpose an alternating current machine of the type A_5, with an exciter dynamo of Ganz's type Δ_1 (the former with a capacity of 50,000 watts at 500 rotations per minute, the latter with a capacity of 3,300 watts at 950 rotations per minute), will be set up. The main primary lead will be carried to a distance of two kilometres as an aerial conductor of 6 mm. in diameter, and from it the leads to the various buildings will branch off at eleven places, for which three transformers of 7,500 watts each, four of 3,750 each, and four of 1,875 each, will come into use and convert the primary current of 2,000 volts into a secondary current of 110 volts. The transformers, where they are set up in the open air, will be placed in iron boxes, whilst those within the buildings will be rendered inaccessible to meddlers by wooden casings. A second alternating current machine will be procured as a reserve, and ultimately the electric light will be extended by means of a third machine to the entire imperial domain Zarskoe-Selo. The order for this installation of transformers was given in consequence of the very satisfactory results which the Imperial Court Inspectors had obtained after a year's experimental working at St. Petersburg. The experimental installation serves for lighting the Imperial Marien Theatre, which is effected by an alternating current machine of the type W_6 for 20,000 watts, driven by a Westinghouse engine by the firm Alley and Maclellan, of Glasgow.

By the adoption by the Imperial Court of the transformer system with aerial leads, a question which has been for some years at issue is decided for Russia. A commission of specialists appointed by the Government had been engaged with the question whether the use of aerial leads for high tension alternating currents should be officially permitted or suppressed. But up to the present date the commission had arrived at no conclusion, though at Odessa a transformer central station with aerial leads, erected by the town, had been at work for three years. Since, now, the Imperial Government has applied high tension alternating currents with aerial leads on an Imperial estate, its permission in Russia, if not yet officially announced, seems to be *de facto* decided. It is likely that the transformer system will soon find satisfactory extension in Russia.

DISCOURSE ON STORING UP THE ALTERNATING CURRENT.

Delivered by Dr. A. FŒPPL, of Leipzig, before the Berlin Electrotechnical Association, April 22nd, 1890.

[COMMUNICATED BY THE AUTHOR.]

(*Concluded from page* 544.)

THE nearest means for effecting the introductions described would consist in a series of plates fixed upon an insulating support, upon which impinge two contact pieces corresponding to the points C and D, and set in oscillatory movement by means of a crank. The single plates would have to be connected by means of conducting wires with points of the battery suitably selected (fig. 4).

An improvement on this most simple arrangement would be effected by coiling the series of plates of fig. 4 upon a cylinder, and putting ordinary brushes in place of the contact pieces. In order to obtain the same introductions as in fig. 4 by means of a simple rotatory

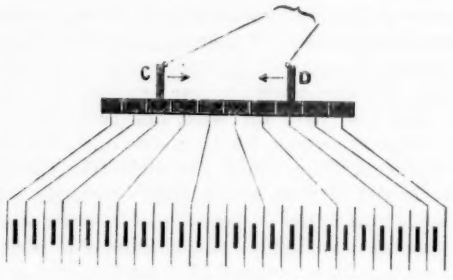


FIG. 4.

movement of both brushes, it is merely necessary to coil the same series of plates twice upon the circumference of the same cylinder, so that each series of plates takes up one-half of the circumference of the cylinder, and both are coiled in the opposite direction; the corresponding terminal plates are then common to both series. The brushes are placed diametrically opposite to each other. Fig. 5 represents this arrangement. The one-half of the circumference of the commutator formed in this manner is taken up by the series

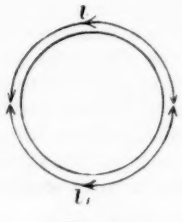


FIG. 5.

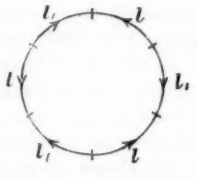


FIG. 6.

of laminæ l, the other by the series g. The arrows point towards the positive pole of each series. This may be expressed in a very intelligible and very characteristic manner by saying that the battery is projected twice on the circumference of the commutator. This statement includes the intimation what points of the battery are to be connected with each commutator plate when the curve of clamp tensions, fig. 1, is to form a pure sine line. I will not, in the meantime, delay with a more detailed explanation, as it will be seen at once that it may be adapted to any given curve by a suitable choice of the points of connection.

In the arrangement of fig. 5 the rotating brushes must turn once for every two changes of the poles or for an entire period of the alternating current. This movement can be effected either by mechanical means, *e.g.*, by means of toothed wheels derived from the movement of the axle of the armature of the alternating current machine, or by a small synchronic auxiliary motor. Of course the brushes may be fixed and the commutator may be caused to revolve, as it depends merely on the relative motion of both. The connection of the commutator plates with the part of the battery thereto pertaining would then be effected by means of sliding rings.

In order to reduce the speed of rotation of the brushes (or of the commutator), the battery may be projected four times, six times, or two n times on the circumference of the commutator, as is shown in fig. 6. The speed of rotation of the commutator would in the case of fig. 6 with 6,000 polar changes every minute amount to 1,000 turns. The brushes would form with each other an angle of about 60°, as is known from the construction of commutators for continuous current machines.

It will be seen at once that such a manifold commu-

tator may be at once directly attached to the circumference of the armature of the alternating current machine in a similar manner to what takes place in the recent large internal pole continuous current machines.

In the above I believe that I have given a sufficiently clear representation of the general arrangement of my apparatus. It would take me too far were I to enter upon a full description of the course of the current in the various positions; the reader will, with little trouble, be able to convince himself that, in fact, the insertions described in the first part of this discourse, and of the corresponding course of the current, will be as there described.

Of the objections or scruples which may be raised against the above-described mechanism, I will submit those which I consider the weightiest to a brief review.

The first refers to the production of sparks at the commutator. For a clear comprehension of the question it will be useful if I first call attention to the close relation between this case and that of the commutator of an ordinary continuous current machine. Fig. 7*a* shows the series of laminæ of the commutator of a continuous current machine uncoiled. Every two successive plates are connected with each other by the interposed armature bobbin, S, which is the seat of an induced electromotive force. As the brush passes between two laminæ the bobbin, S, concerned is short circuited, and the current in the latter is reversed. Fig. 7*b* gives the series of laminæ of the apparatus here described and its connection to the battery. On the transit of the brush, a momentary short circuit of the part of the battery between two laminæ cannot be avoided, and the current vanishes in one of the connecting wires whilst it appears in the other. The close relation of both cases is here evident.

It is known that by a clever utilisation of an induced force which the reversal of the current effects in the short circuited bobbin, the problem in question is well solved for fig. 7*a*. We might then hope to arrive in a

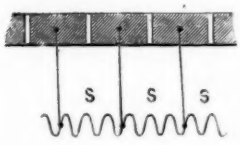


FIG. 7*a*.

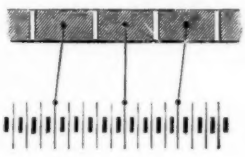


FIG. 7*b*.

similar manner at the solution for fig. 7*b*. However, the difficulty of avoiding sparks for fig. 7*b* seems smaller than it originally was for the commutator of the continuous current machine. Whilst in the latter the self-induction of the bobbin to be re-introduced increases the difficulty of the question, this in fig. 7*b* is practically null. We may therefore obtain our object with simpler means, of which I merely mention here double brushes and a gradual cutting out by the interposition of resistances free from induction.

Of course, we can arrive at final results on such details of construction only by experiments on a large scale. Such experiments are now in progress, but I am not yet justified in communicating the results.

The second objection refers to the consideration that the curve of clamp tensions, fig. 1, may vary with different loads. If the battery is connected with the commutator so as to correspond to a certain form of this curve, irregularities may easily occur in consequence of a change in its form. But we may readily satisfy ourselves that when the principal work of the machine consists in charging the battery, the self-induction of the alternating current machine helps us over this difficulty. In other cases, indeed, a partial discharge of the battery may occur, so that single cells may be charged to a higher tension than others until a new state of equilibrium has been reached. But this does not involve any injurious results. The battery can adapt itself to such fluctuations, and, on the other hand, it may prescribe up to a certain degree of the clamp tension a normal form for the main lead. It produces in this respect a more stable condition of the current. It must be remarked that even when the curve of clamp tensions becomes distinctly unsymmetrical (in consequence of a strong reaction of the armature) this may be met by projecting the battery upon *l* in fig. 5 in a different manner (*i.e.*, seeking different points of connection) than at *g*.

It remains for me merely to point to the applications which the new procedure may find in practice. In my opinion, it is likely to perform for the technics of the alternating current still more important services than the use of accumulators has afforded in continuous current technics.

In the first place, the storage of the alternating current can be carried out in the same manner and for the same purposes as in continuous current installations. This manner of application is so simple that it requires no further description. But, in addition, there are other applications possible, of which I will briefly describe the two most important.

The first is the question of alternating current motors. Suppose that in any part of a city supplied with the alternating current a large alternating current motor is to be installed. Instead of feeding it directly from the main lead we arrange, in the first place, an alternating current battery which is set in action by a small synchronic auxiliary motor. The main motor carries likewise a commutator at the circumference of its armature which receives the known introduction from the alternating current battery. We perceive at once that in this arrangement the main motor is not limited to the conditions of synchronism. It can be driven at any desired speed, bears as much over-loading as does a continuous current motor, and behaves in every respect like the latter. The accession of the alternating current battery certainly complicates the arrangement a little, but it involves other decided advantages.

The other application is in the erection of alternating central stations. I figure to myself, in the first place, at such a station the construction of a main battery. Upon this work all the alternating current generators of the station, each of which is furnished for this purpose with a commutator at its armature. It must also be noted that the excitement of the field magnets can be easily effected from the battery.

The alternating current to be given off outwards will be derived, independently of the machines, from the battery by means of the rotating apparatus above described.

We perceive at once that in this arrangement every machine works independently of the others. The question of parallel introduction is completely solved. Every machine can run with a different speed, and each can at any given moment be in a different phase. The introduction of a new machine is effected in exactly the same manner as with a continuous current central.

You may object that it is not suitable first to store up energy in a battery, and then draw it out again. In practice the case is different. In normal working, *i.e.*, when the machines produce exactly as much current as is used in the outer circuit, the battery forms merely an apparatus for introduction. At each moment there exists a series of ramifications which allow the chief part of the alternating current supplied by machines in parallel insertion to flow off at once directly into the external leads without having been previously transformed into chemical energy. Only a small fraction of the entire energy undergoes a temporary storage. This fraction is the smaller the larger the number of the alternating current machines working upon the battery, and the greater at the same time is the number of the apparatus for taking up the current.

An important advantage of this arrangement seems to be in the circumstance that in the construction of the alternating current machines we are not limited to any large prescribed number of polar changes. It may, at pleasure, be made smaller than formerly, and hence a better utilisation of the magnetic field is obtained. Hence we may expect an increase of the useful effect of the machines, which may to a great extent compensate for the losses occasioned by the arrangement for introduction.

In order to obtain the prescribed number of polar changes in the exterior not only the apparatus for taking up the current must rotate at a very high speed. We may say that with the arrangement above described the battery constitutes a transformer of a new kind. It transforms alternating currents of various and low numbers of alternations which flow from the machines into others of an accurately determined and higher number of alternations which flows off outwards.

I hope that these indications will suffice in order to give in general outline a picture of the manifold applicability of the new procedure. I may conjecture that this process will be of great scope for the future development of electrotechnics.

Finally I remark that I am fully conscious that a final decision as to the practical value of my method can be obtained only by means of extended experiments. I have not waited for the completion of these experiments and have come before the public because I wished to discriminate between that which is my exclusive mental property and that which has been derived—and which will be derived in future—from the execution of the experiments and the practical carrying out of the idea and which will be in great part due to the merits of others.

PATERSON'S ELECTRIC TARGETS.

THE principal objects of rifle ranges or butts are to teach volunteers and soldiers to shoot straight; but the methods usually adopted for indicating the exact spot struck by the bullet are extremely crude and, in some cases, dangerous. It was with a view to overcome the danger and to enable firing parties to ascertain for themselves the actual spot hit by their bullets, that Mr. J. Paterson turned his attention to the subject, and he has devised an ingenious system of electric and self-indicating targets.

The electric system may be divided into two parts, the first being the electric target and the second the indicating apparatus. The competition target, which represents the bull, inner, magpie and outer, is formed of concentric iron rings, with the exception of the outer which is square. At the back of each ring or square is a strong horizontal spring which is almost in contact with a vertical lever. On a bullet striking any one of the four sections, that particular section and its corresponding spring are forced back until the spring hits its respective lever, causing the latter to fall into a horizontal position. As the lever falls it establishes, by means of contacts and a battery, electrical communication with the indicating apparatus erected at the firing end of the range, thus showing which section of the target has been struck.

The indicating apparatus is an oblong wooden case placed in any convenient position and having a blackened glass front. Nearly at the top of the latter are four horizontal strips, white for the bull, red for the inner, black and white for the magpie, and black for the outer. These strips correspond to the sections of the target. At the bottom of the case at the back of the glass is a verticle slot about $\frac{3}{4}$ inch wide and 4 inches long. The case contains five pairs of electromagnets, one for each section of the target, and one for an electric bell common to all the sections. Each magnet has an armature attached to a lever which terminates in an oblong piece of metal plate corresponding in colour to the horizontal strips and therefore to the target sections. It will be evident that on a bullet striking, say, the bull's eye, the corresponding lever is knocked down and electrical communication is established between the contact piece and the bull's pair of magnets. The armature is attracted and the movement of the lever causes the white plate (the bull), to travel immediately behind the before-mentioned slot, so that the rifleman may see for himself that his shot was a bull. At the same time the current on its return causes the electric bell to ring until the circuit is broken. The latter takes place when, by pulling a cord, a brush is caused to rise over the face of the target to remove the flattened bullet. The raising of the brush simultaneously breaks contact by lifting the lever to its normal vertical position, and as the armature is released the lever with its indicating plate also assumes its original position and the bell ceases ringing.

This kind of target answers exceedingly well, but it sometimes happens that a bullet splits and strikes two sections of the target at the same time. Thus two of the indicating plates appear simultaneously behind the slot, one plate covering, or almost covering, the other, so that, in the case of two persons firing at the same target, there is a possibility of disputes arising. This, however, only occurs very seldom, but an improvement in the indicating apparatus has been introduced by Mr. E. R. Hedgman, of 23, Castle Street, E.C. In this improved indicator the plates are dispensed with and a pointer, which travels over the face of the coloured strips, is substituted.

Another form of target is the self-indicating class firing target, which is purely mechanical. This target is also built up in sections, having back springs and levers, the latter having attached to their lower ends numbered cards with large figures representing the various sections. Thus, on any one section being struck by the bullet, its particular spring throws over its corresponding lever, and the numbered card is visible from the bottom of the target. The card and lever are raised, and the flattened bullet removed in a similar manner to that adopted in the electric target. These targets are now being introduced by the Electric and Self-Indicating Target Company, who have erected two ranges in London, one at 391, Brixton Road, and the other in Newington Butts, where they are well patronised. Two of these ranges are in operation at the French Exhibition, which opened at Earl's Court last Saturday. These two ranges will be lighted by five Planet arc lamps supplied, together with batteries, by the Weymersch Battery Syndicate. This system of electric targets is shown at the Royal Military Exhibition, whilst in Scotland many of these targets are employed, and the system is also coming into use in English rifle ranges.

THE ELECTRIC LIGHT AT KARLSBAD

(FROM A CORRESPONDENT.)

THE construction of electric works at Marienbad has naturally given an impulse in the kingdom of Bohemia, so rich in popular watering places, and already a second, and larger place, Karlsbad has followed the example of Marienbad. The municipal assembly of Karlsbad resolved a few days ago to erect electrical works, adjacent to the waterworks, for lighting the town. The installation will have a capacity of 5,000 glow lamps of 16 candle-power. Two proposals have been submitted to the municipality, the one by Siemens and Halske, of Berlin, and the other by Ganz & Co., both based upon the use of alternating current transformers. The latter offer was accepted. As a reason for the installation of the works, it is stated in the report of the council that Karlsbad, as a world-famed watering place, could not remain behind towns which have already introduced the electric light.

The proposed central station will include four safety tubular boilers, each of 150 square metres heating surface, with the necessary pumps, injectors and water-pipes; further, four steam engines of 125 H.P. each, connected directly with four alternating current dynamos of the type A_6 (360 rotations per minute), two exciters with their separate accessory engines, and all the fittings required for the parallel introduction of the alternating current machines and altogether for working shunts, measuring and control apparatus. The total cost of the arrangement in the central station reaches 123,000 florins.

The cost of the conductive net which consists of underground concentric cables enclosed in iron sheathings,

and of the transformers (37, each of 7,500 watts), as well as of the brackets and columns for the glow and arc lamps for street lighting (45 of the latter), amounts to 150,000 florins.

The town has also voted 75,000 florins for the erection of the engine and boiler houses belonging to the electric works for the foundations of the engines and boilers and for laying the underground cables.

Altogether the town has voted 400,000 florins for the installation, in order that there may be sufficient funds for the internal fittings of the municipal buildings.

It is curious that the town erects the electric works at its own expense, and that, nevertheless, the working will be conducted by the Joint Stock Machinery Company, of Nürnberg (formerly S. A. Hilpert & Co.), which is in possession of the Karlsbad Gas Works, so that the gas company takes over the municipal electrical works up to December 31st, 1902, and consequently retains in its hands the entire public lighting of Karlsbad.

The electric current will be charged to the consumers by means of meters which will be supplied and maintained by the electric works. For the loan and maintenance of these meters the consumers pay yearly :—

Up to 10,	16-candle glow lamps	...	...	10 florins.
10—25	„	„	...	...	14 „
20—50	„	„	...	...	18 „
50—100	„	„	...	...	20 „
100—200	„	„	...	...	30 „
200—300	„	„	...	...	40 „

For every lamp installed the works will charge a yearly fundamental ground tax without reference to the actual use of such lamps. It will be :

a. For Glow Lamps—

Per lamp of	10	candle-power	...	...	...	2 florins.
„	„ 16	„	...	...	...	3 „
„	„ 32	„	...	...	...	6 „
„	„ 50	„	...	...	...	9 „
„	„ 100	„	...	...	...	18 „

b. For Arc Lamps—

Per lamp of	8	ampère	...	...	...	24 florins.
„	„ 12	„	...	...	...	36 „

and at other strengths in proportion to the above strengths.

The calculation for the supply of current is effected so that the unit of calculation is the energy of 100 watts hourly. The price for 100 watts per hour has been fixed for the entire duration of the agreement at 4 kreutzer. Hence the maximum prices for the various strengths of light, as above, will be :

For every hour's burning of a glow lamp at					10	candles	1·5 kreutzer.
„	„	„	„	„	16	„	2·3 „
„	„	„	„	„	32	„	4·6 „
„	„	„	„	„	50	„	6·9 „
„	„	„	„	„	100	„	13·8 „
Arc lamp at	8	ampères	...	...	...	...	18·4 „
„	„ 12	„	...	...	...	...	27·6 „

A discount of 4 to 15 per cent. will yearly be allowed to consumers burning more than 600 hours.

For the concession of the electric works with the conductive net, and the meters for use during the lease, the gas company will in the first place pay the town yearly 4½ per cent. interest on the capital expended, further a yearly quote of 1½ per cent. towards the sinking fund, and lastly 50 per cent. of the clear profit on the supply of current. On the other hand, the town renounces the right during the time of the agreement to erect or permit to be erected in Karlsbad any other electric works up to the year 1902 so that the gas company monoplises the entire lighting of Karlsbad, both with electricity and gas.

The Karlsbad electric works will be built at Donitz, about 2 kilometres outside the town. We may now assume that all the other Bohemian watering places will follow the example of Marienbad and Karlsbad.

COMMUNICATIONS FROM ITALY.

[FROM A CORRESPONDENT.]

IN my last communication (in your journal of April 25th) on a death occasioned by a high tension electrical current, there occurs a clerical error. It happened not at *Terni*, but at *Turin*. Concerning this unfortunate event the report has since been issued by the director of the Societa Generale per la Illuminazione (which carries on the central station at Turin) to the effect that it was occasioned by the high tension alternating current of the installation of transformers there. The workman concerned had in a private house connected with the conductive net, in which a transformer had been placed, to re-introduce at night into the primary circuit the switch by which the transformer had been cut out in the morning. After this had been done his hand came into contact with the primary terminals of the transformer, which occasioned the death of the unfortunate victim. It is simply inexplicable how this could happen, since the entire arrangement was such that in manipulating the switch there was no occasion to come in contact with the transformer, directly or indirectly. The switch is placed to one side of and under the transformer, so that an accidental contact with the transformer when setting the lever of the switch seems absolutely out of the question. This circumstance gave rise in some quarters to the suspicion that the deceased had committed suicide (?) on account of domestic differences in his family. It is remarkable that, according to a former communication from the director, the victim lived fully a quarter of an hour after he had received the electric shock.

A communication on this accident, which I have just received from an engineer of the company, fully confirms the report of the director. Proceedings are threatened against the company for "*omicidio involontario*," but this project will probably fail, since, according to a formal report by Prof. Ferraris, the entire installation has been carried out in the most approved manner, and the accident must have been occasioned by gross negligence of the workman entrusted with turning the switch, so that the company is not at all responsible for the catastrophe.

In Naples, the firm Schuckert, of Nürnberg, which has erected an electric central station in that city, has just published a scale of charges for the supply of the electric current. The subjoined figures show that the carrying on of electric works in Italy must be a very remunerative business. For a glow light there will be paid, besides a monthly fundamental tax calculated at per lamp, a charge either per lamp-hour, or per ampère-hour, and a monthly sum when the consumer has the option of burning the lamps up to any hour of the evening or night agreed on. These modifications are marked in the price list as A, B and C.

Glow lamps at normal candles.	A.	Charge per lamp hour.	B. Monthly charge for lamps which may burn till . . . . o'clock.							C.	
	Monthly charge.		9	10	11	12	1	2	3	Monthly charge.	Charge for ampere hour.
10	2·25	0·03	5·05	5·95	6·85	7·75	8·65	9·55	10·45	2·25	0·09
16	3	0·04	6·25	8	9·25	10·50	11·75	13	14·25	3	0·09
25	4	0·06	9·50	11·30	13·10	14·90	16·70	18·70	20·30	4	0·09
32	6	0·08	13·35	15·75	18·15	20·55	22·95	25·35	27·75	6	0·09

In these prices the wear and tear of glow lamps is included, lamps uninjured outwardly, but with a broken filament, are exchanged gratis.

The tariff for arc lamps is given under D and E.

Arc lamp per ampère.	Monthly charge.	D.	E. Monthly scale for lamps burning until						
		Charge per hour.	9	10	11	12	1	2	3
4½	23	0·20	44	49	56	62	70	80	90
6	33·50	0·30	61	70	79	88	97	106	115
9	46	0·45	87	101	114	128	142	156	170
12	60	0·60	113	131	150	169	188	207	226

These prices include the maintenance of the arc lamps. The prices under A and D are reckoned according to electric meters; those of C according to self-registering ammeters. The prices are given in Italian *lire*. Thus according to scale A the consumer pays for a 16 candle glow lamp, 4 centimes per lamp and hour of burning, besides the fundamental tax of 36 lire yearly; for a 12 ampère arc lamp the charge is, on tariff D, 60 centimes per lamp and hour of burning, besides the fundamental tax of 720 lire yearly.

The Societa Generale per la Illuminazione is also competing for a concession for erecting a central station in Naples on the alternating current transformer system, since the Schuckert installation which uses the continuous current supplies only a limited district. In the meantime it has put up some isolated installations but as it encountered difficulties with the introduction of machinery into houses it has made use of accumulators, which are charged at a station about 2 kilometres off, where there have been set up 4 dynamos of 40,000 watts each.

The central transformer station erected at Syracuse by the Milanese Edison Company was set in regular action on April 14th.

EDINBURGH EXHIBITION.

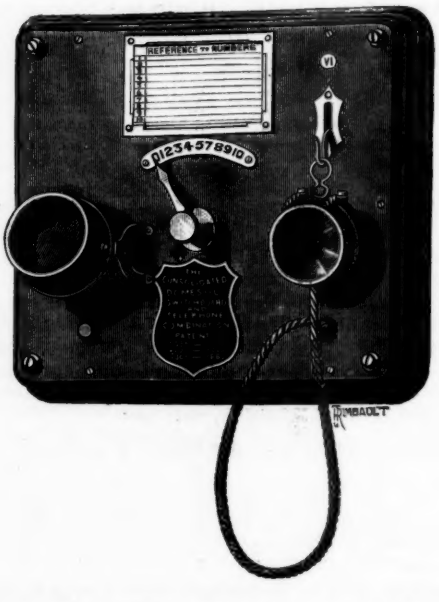
SOME EXHIBITS.

No. 1. *Post Office Exhibit.—Telegraphic Section.*—The premier place in the catalogue is fitly occupied by an interesting collection of apparatus illustrating the earliest practical applications of electricity to the wants and comforts of man. Mr. J. Gibson, Superintending Engineer, Postal Telegraphs, Edinburgh, has arranged a most instructive telegraph section, including not only items possessed of historical interest, but also a comprehensive display of the instruments at present in use in the British Post Office. Among the former there is shown some of the earliest methods by which telegraphic communication was sought to be established. Cooke and Wheatstone's earliest needle instrument (1837) is shown, along with a piece of what is known as the fossil telegraph or line used by Cooke and Wheatstone under the Euston and Camden Railway at that time. This consists of a triangular block of wood through which five wires were threaded, the wood being covered with a coating of spun yarn dipped in pitch, no other apparent means being taken to ensure insulation. There are also examples of the telegraph needle, both single and double, used by the same inventors in 1838 and 1844, and other antique forms of transmitting apparatus. A specimen of the Hughes type-printing instrument is exhibited, which was actuated by a piano key-board establishing a current, and depressing the wheel bearing the types. Bain's chemical telegraph of the year 1850 is also shown, as well as a double needle instrument made in 1851 for use in the House of Commons, and having an elaborate Gothic case specially designed to correspond with the architecture of the building in which it was placed.

Among the forms of submarine cable is a single-wire gutta-percha covered specimen, rescued from the Persian Gulf, and showing damage done by a teredo; a piece of the first submarine cable between Dover and Calais of the year 1850, which was picked up in 1875; and also a specimen of the 1858 Atlantic cable, picked up in 212 fathoms of water by the *Scotia* in August, 1880. By the side of this may be seen the strong steel-sheathed cables of the present day, laid down by various Governments for long deep-sea distances. Of insulators which have undergone great development, both in form and material, there is also an interesting show, notably the insulator known as Physick's, of the year 1848—a very primitive type. Of minor exhibits, there are sets of joints showing the evolution of the practice of binding wires together to make a continuous line, and other details of great interest from a historic standpoint.

No. 7. *Consolidated Telephone Construction and Maintenance Company.*—This company has a good display of the great variety of telephones and telephonic material, which it is prepared to supply for complete installations by telephone companies abroad, as well as for private purposes. The systems represented include Bell, Edison, Blake, Gower-Bell, Hunnings and others. Specially worthy of notice is a very useful instrument combining receiver, transmitter, call-bell, switchboard and automatic switch.

The patent automatic switch is of great value to the user, inasmuch as it is an utter impossibility for the pointer to remain on a used line. It returns automatically to its normal position, O, after the user has spoken to whatever number he has wished.



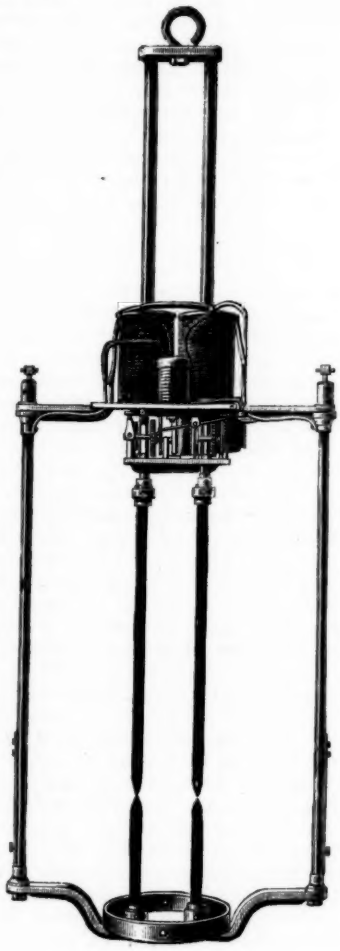
The working of this switchboard is as follows:—Supposing that 10 rooms or offices of a building have to be connected as a system. One of the combinations (as per illustration) would be placed in each room or office. Say that No. 5 requires No. 3—No. 5 places the pointer to No. 3, presses the ringing button under the transmitter, removes the receiver from the switch-hook, and after conversation replaces it. The very act of his doing so causes the pointer to return to O, and the line is thus cleared.

The same company exhibits the Simplex arc lamp, lighting its own stand and also the National Telephone Company's room.

The chief characteristic of this lamp is that it consists of fewer parts than any other existing lamp. Another feature is that it is designed to work in parallel arc with incandescent lamps, as well as in series. When used in conjunction with incandescent lamps, no costly regulating devices are required. By a simple adjustment of a screw, the lamp can be worked with different E.M.Fs. and strengths of current.

The lamp consists of a single solenoid in the main circuit having a hollow iron core, through which passes

the upper carbon rod, made in the form of a rack. The iron core is supported by suitable adjustable springs to the bottom flange of the coil, and has affixed to it the simplest mechanism for controlling the feed or descent of the upper carbon. The electrical action is as follows :—The current enters the solenoid, the iron core is attracted or sucked up, thus separating the carbons and "striking the arc;" as the core is drawn up the



rack is locked, and remains so, as long as the current in the solenoid remains constant. As soon, however, as the current strength in the solenoid is reduced, the core slowly descends, allowing the rack, and with it the upper carbon, to descend also, until the resistance of the arc becomes normal, when the core will be again attracted up, and the rack locked. There is, therefore, no jumping or flickering of the light; its steadiness equalling that of an incandescent lamp.

No. 8. *London and North-Western Railway Company.*—Mr. J. W. Fletcher, Chief Telegraph Superintendent of the London and North-Western Railway Company has a most interesting exhibit of railway signalling apparatus, including his patent electric locking apparatus and his patent three-wire combined block telegraph. One of the most important inventions here shown is an electric fog signalling apparatus (also Mr. Fletcher's patent), for conveying an audible sound to the engine driver in case of fog when the signal is at "Danger." It is actuated by treadles, under the control of the signalman at the next signal box or station. Fog having come on, and the treadles having been set in position, the coming train in the act of passing completes an electric circuit, setting in motion a small electric motor, which operates a foghorn. This continues to sound till the arrival of the train at a given spot, where a similar treadle breaks the connection. In a kindred apparatus an electric detonator is substituted for the foghorn arrangement. This is a wheel with 50 recesses on its rim, each holding a cartridge, the result of a train passing one of the treadles being to put in motion the mechanism, which discharges one cartridge and shifts the wheel so as to bring the next one into position. The whole 50 can be thus fired in succession without any personal attention.

Mr. Fletcher also exhibits an electric light "pull switch," without ratchet gear, which avoids the necessity of "wiring down." The pulling of the cord puts the light "in" if "out" and "out" if "in."

In connection with this exhibit may be mentioned a novelty of some interest, also shown by the London and North Western Railway, but located in the Locomotive Court. This is an electric staff apparatus (Webb and Thompson's system). Under the ordinary way of working the staff system it is impossible, after starting a train on any section of the line, to follow it by another till the staff sent by the first train has been brought back from the far end of the section to the starting point, but with the aid of this invention two or more trains can be sent over a line in the same direction without having to wait for the return of the staff. This is accomplished by means of an electric lock arrangement operated from the station to which the staff has to be forwarded. Two line wires are used for this purpose, which the inventors call the "top" line and the "bottom" line. Assuming all the staffs are in magazine, and that station A wishes to forward a train to B. To do this A rings to station B that he has a train waiting, upon which B sends a current to A along the bottom line which unlocks the electric lock at A. A then withdraws a staff, and in doing so switches his electric lock on to the top line, whilst B's is still coupled up with the bottom line, and hence another current sent in either direction would not affect the locks at either station. The staff withdrawn at A is carried to B by the driver of the train, and replaced by B in his magazine, in doing which his lock is also switched on to the top line, and both locks being now on the same circuit, a current sent from either end will unlock the apparatus and allow a staff to be withdrawn. To further increase the usefulness of the apparatus the inventors have adapted each staff to act as a key to the locks of intermediate sidings.

No. 24. *Babcock and Wilcox Company.*—This company has an instructive representation of one of its boilers, showing not only the boiler itself, but the manner of setting and mode of operation. The important advantages secured in this form of water-tube boiler are perfect circulation of the water, ensuring an equality of temperature in all the parts; ample steam and water capacity, rapidity of steaming and resistance to the heaviest firing, economy in fuel, in space occupied, and in up-keep; safety, durability, facility of transport, accessibility to all its surfaces for cleaning, simplicity and thoroughness of construction, and facility in the replacing of any part, such renewal leaving the boiler integrally as if new. The electrical engineers of Europe have not been slow to recognise the superiority of the Babcock and Wilcox boiler in these respects, and it has been adopted for most of the large central stations in existence.

No. 28. *Carrick and Ritchie.*—This firm of hydraulic engineers, who have supplied the water-power to a number of installations in the country, endeavour to show what may be done in the way of applying water-power to the production of electricity, both for lighting and power, by means of turbines and other water motors manufactured by them under patents secured to Mr. John Ritchie. The Waverley turbine is shown combined with an Elwell-Parker dynamo. If used for charging accumulators, for which duty a very small stream is sufficient to drive the apparatus all day, it will produce current for 100 lights at night, or 60 lights could be run direct from the machine. This turbine is fitted with King's patent governor, which controls the inlet-gate of the turbine, so that the lights may be switched off or on at pleasure, without affecting the strength of the current or the brilliancy of the lights. Other forms of Waverley turbine are also shown, as

well as one on the Girard system, specially made for high falls up to 300 or 400 feet. A number of these have recently been sent to Ceylon, where there are very high falls of water. The great superiority of water as a perfectly steady driving power for electric light machinery is not to be overlooked, and the fact that many of the streams flow from their source to the sea, without being made to give up any useful work on the way, augurs well for a large application in the future of this much neglected power.

In order to show what can be done by applying towns' water supply to produce power, a small jet motor is fixed, and is to be shown at work driving a dynamo for electric lighting. The water is taken from the main pipe in the exhibition, where there is a pressure of about 50 lbs. to the square inch. The water, after being used in the motor, is returned to a large tank, and used for feeding the boilers, and is thus not lost. In view of an increased water supply to Edinburgh this machine is a highly interesting one; there is hardly any purpose requiring a small motive power from $\frac{1}{10}$th 1 H.P. to which it cannot be applied. It uses the water in the most economical manner, as it has two jets, both of which can be used when all the power is required, and one only when less than the full power is wanted; by this means the pressure of the water is not lessened by being drawn through a partly-closed orifice, but is allowed to pass into the machine with the full pressure in the pipe due to the head.

Rivetted steel pipes, which are fast superseding cast-iron ones for the conveyance of water to turbines and for other purposes, are also shown. These are capable of standing a very high pressure without risk of fracture, so common with cast iron pipes. For export purposes they are invaluable, being only one-fifth of the weight of cast iron pipes in proportion to their strength and carrying capacity.

Correction.—We learn that the Concert Hall is lighted, not by the Sunbeam lamp, but one similar in appearance made at the Woodside Electric Works, Glasgow.

SIR WILLIAM THOMSON'S PAPER READ BEFORE THE ROYAL SOCIETY, EDINBURGH.

By S. ALFRED VARLEY.

IN the year 1840, a man in charge of an engine at Seghill, near Newcastle, accidentally had one hand immersed in a jet of steam issuing from a leak in the boiler at the same time as he reached his other hand towards the valve lever, and to his surprise he received an electric shock. This sensational experience coming to the knowledge of Mr., now Lord, Armstrong was at once scientifically investigated, and shortly afterwards the hydroelectric machine was produced. The principles underlying the production of electricity by effluent steam were further investigated by Faraday, and the results he obtained were communicated to the Royal Society, and a lecture was also delivered before the members of the Royal Institution. Nearly 50 years have elapsed since what has been above related occurred, and a paper has been very lately read at Edinburgh on what its author, Sir William Thomson, has described as the "wonderful accidental experiment of Lord Armstrong."

Lord Armstrong accidentally short circuited a dynamo developing a current of 83 ampères at a pressure of 103 volts, with a steel bar he was holding. What immediately followed was a painful sensation in the hand causing the bar to be dropped, but *time enough elapsed* for severe blisters to be formed where the fingers touched the steel. Lord Armstrong does not appear to have further investigated the matter, beyond observing that the steel bar, which was picked up immediately afterwards, was not perceptibly heated.

Sir William Thomson in his paper (an abstract of which is reproduced elsewhere in this journal) says, "This marvellous incident proved (1) the outer surface of the steel to have been intensely heated; (2) that not enough heat was generated to sensibly warm the whole bar. The explanation, of course, is to be found in the known laws of diffusion of electric currents through non-magnetic conductors considered in connection with the effect of magnetic susceptibility, of unknown amount and law, in conductors of steel and iron." Thomson also states that "the requisites for fully working out the theory of transient currents in conductors of any form are included in Maxwell's fundamental questions, and are given explicitly for straight cylindric conductors of non-magnetic material;" and further, reference is made to a paper of Lord Rayleigh as giving the formula "for transient currents in straight cylindric rods of iron," and also to the very comprehensive manner in which the subject has been investigated by Heaviside.

To the thoughtful outsider the query naturally occurs, how is it that what our mathematical physicists have for the last few years regarded as an important advance in electrical theory, and which has been subjected to such an exhaustive investigation mathematically, has been allowed to remain without any experimental verification, until an accidental experiment was performed by Lord Armstrong; and, furthur, how is it that Lord Armstrong's experience, instead of being regarded simply as confirming what in the opinion of Thomson and other eminent physicists had been already theoretically demonstrated, should be considered to be a "marvellous incident?" It cannot be otherwise than a matter for regret that Sir William Thomson did not investigate the matter experimentally before allowing his paper to be read. Sir William Thomson has the resources for experimenting at his immediate command, and the writer ventures to think the question could be set at rest absolutely in the following way: Bore a hole in the side of a steel rod down to the centre and insert a small rod of an alloy of antimony and zinc inside the hole, insulating it from the sides, but uniting the antimony zinc rod to the bottom of the boring by plumber's solder; a thermo couple in connection with the centre of the steel rod would in this way be constructed, the steel itself forming one of the elements, a second pile could also be constructed by soldering another rod of the thermo-electric alloy to the surface of the steel. These thermopiles would be more sensitive to differences of temperature than the human skin, and if they were connected through two of Thomson's reflecting galvanometers and electric alternations transmitted through the steel rod the galvanometer deflections would indicate at once whether the other skin of the conductor was heated sooner than the interior.

A very considerable development of heat would be necessary to severely blister the fingers; and if, as Sir William Thomson takes for granted, that the blisters were produced by heat conduction from a highly heated surface, then a sensible interval of time must necessarily have elapsed before the cuticle could be raised to a blistering temperature, and a further small interval of time would elapse before the steel was dropped, and therefore it seems difficult to understand how, under such circumstances, on the assumption that blisters were formed by suface conduction of heat, that the steel bar itself was not bodily heated.

Lord Armstrong has very kindly informed the writer that the dynamo was a continuous current one, and this increases the difficulty in accepting the explanation given by Thomson as a conclusive demonstration that the surface of the steel was so highly heated as to be capable of producing severe blisters, and yet not be capable of perceptibly heating the bar as a whole. The blisters were, of course, a consequence of a development of heat, and the suggestion obtrudes itself, was it not possible that Lord Armstrong's fingers formed unwittingly part of an electric circuit. Momentarily short-circuiting a dynamo would give rise to a sudden increased development of current, and possibly to a

production of "extra current." In the early days of dynamos the writer himself happened to have one hand resting on the iron framework of a large Gramme machine at the time a sudden change of resistance occurred in the working circuit. He was scarcely conscious of having received a shock, he experienced no pain whatever, but owing to a sudden contraction of the muscles he fell down and found himself afterwards very faint. The late Robert Sabine, who was present at the time, demonstrated theoretically that it was not possible for the writer to have received any shock, but nevertheless he was laid up for a few days afterwards, and as Faraday used to say, facts stand before all theory.

Electric welding experiments, extending over a week, have lately taken place at the Institution of Civil Engineers. In the course of these experiments iron bars of as large a diameter as 1½ inches were welded, and cylindric iron bars of various diameters were heated to a white heat, a rectangular frame of cylindrical iron, forming a continuous circuit, was also placed in the jaws of the welding machine, this arrangement was something like a Wheatstone's balance, there being two paths for the current, which became divided through two arms of unequal resistance, the shorter conductor being only a few inches in length, and the longer one, say, four feet. The object of this experiment was to show that under such conditions the whole of the current practically passed by the shorter route which became raised to a white-hot temperature, the longer one being grasped in the hand of a workman all the time the experiment was being performed.

In these experiments the bars were heated by electric alternations developed by a transformer which was itself excited by an alternating current dynamo, and the current was estimated by Crompton as highly as 30,000 ampères. Now if the recent developments of theory are correct, it is thought the outer skin of the iron rods would have become liquified before the centre of the rods could have become raised to a welding temperature by heat conduction, and seeing the inertia resistance which must have been opposed to alternations of such powerful currents, one would have expected that in the experiment of the rectangular frame, if there had been any crowding of the currents in the outer skin, that the longer path would have been too highly heated for a workman to be able to grasp at the time the shorter path was being raised to a white heat.

Sir William Thomson will admit that the electric welding experiments referred to were very practical ones, and it is thought he will find it difficult to reconcile what was there observed, with what he has described as the "*known laws*" of the diffusion of transient currents.

This article is not written in a partisan spirit, and the writer proceeds to direct attention to certain matters which the mathematical physicist may claim, and, perhaps, fairly claim, as qualifying to some degree what was observed in the course of the electric welding experiments.

In the columns of this journal the writer has attempted to analyse inertia, and he has ventured to express the opinion that overcoming inertia is simply imparting energy to matter, and that as the inertia which is associated with all matter, and which is its distinctive feature, as contrasted with that of force, opposes resistance to external energy, work has necessarily to be performed to overcome it, and the equivalent of such work is represented by motion, either internal or bodily, being set up in the matter whose inertia has been overcome; (2) that so long as the energy which has been imparted remains associated with the matter, motion of some kind continues, and the energy which has set up this motion can *only* be parted with by becoming transferred to some other receptacle.

The phenomena attributed to self-induction have been analysed also and divided into what the writer has termed magnetic inertia proper, and self-induction. The magnetic inertia of a conductor, according to the writer's definition, is directly as its mass multiplied by its specific magnetic inertia or magnetic gravity, the term self-induction he regards as expressing that increase of magnetism which is brought about by the mutual induction of magnetised molecules on one another, and which has the effect of further raising the magnetic polarisation.

Magnetic inertia proper is not affected in any way by the shape of the conductor any more than the relationship of matter to the force of gravity is affected by its shape, but self-induction, on the other hand, is greatly influenced by the form of the conductor. For example, the self-induction in a ribbon conductor is less than that of a cylindric one, for the reason that the molecules are, as a whole, further apart from one another than they would be in a cylindrical conductor of the same weight and length, and for similar reasons if a straight conductor be formed into a helix the self-induction will be found to have become very much greater than what it was when in a straight length. Now, as what has just been stated is the result of experimental observation and does not arise out of the development of a theory, it is thought that practical men will be disposed to accept the writer's views in respect to self-induction, and he does not anticipate that any mathematical physicist will venture to dispute their general correctness. Now the molecules of iron loose their magnetic properties at a full red heat, and self-induction as defined by the writer should cease altogether when such temperature has been reached, it would therefore seem probable that the inertia resistance which red-hot iron opposes to rapid electric alternations would become very much reduced and whatever inertia was opposed would be that which the writer has defined as magnetic inertia proper.

It will of course be admitted that the resistance opposed by an iron conductor to rapid electric alternations is chiefly inertia resistance; that being so, it follows on the assumption that if the alternations are confined to the outer skin, it will be in the outer skin where the heat is first developed, and as the self-induction decreases when the temperature becomes raised, the effect would be to bring about a greater crowding of current in the outer skin, and this should continue until such time as when the centre of the iron bar bas become raised to a red-hot temperature, by heat conduction from the exterior; but before this would have occurred it is thought that, if the mathematical view were the correct one, the outer surface should have become liquified.

At the risk of being considered sadly wanting in reverence to constituted scientific authority, the writer dares to think that researches such *even* as those of Prof. Hertz would have a higher value if only our physicists would set themselves the task (common place and elementary as it may be considered) of answering such a practical question as how is it mentally conceivable for an entity not possessing weight to oscillate, seeing that our present knowledge seems to demonstrate (1) that oscillation involves inertia, a convertible term for weight, (2) that the only entity possessing weight we are acquainted with is matter, (3) that as all motion involves matter as well as energy, it would seem to follow as a logical sequence that all oscillation must be a product of matter and energy.

There are two great schools in the world, the practical school and the theoretical and more exclusively scientific school. The disciples of the former recognise the very narrow limits within which the human intellect is confined, and therefore they are willing to sit at the feet of nature and to seek for information through the medium of observation and experiment, and it is to those trained in this school, be they engineers, or be they scientists, that the world is indebted for more than nine-tenths of real scientific progress.

In the more exclusively scientific schools, the student has knowledge imparted to him ready made, and he is taught to glorify the human intellect, which he comes to regard as the highest outcome of all that exists, and therefore he is led to worship his own intellect and to pay the greatest reverence to that of his more highly gifted teachers. Men trained in so contracted a school are only too ready to accept what, at the best, is only an

emanation of the brain of a gifted man, as an absolutely solid basis on which a scientific edifice may be safely reared, and they will industriously devote years of their lives to calculating out developments of what is after all *only* a hypothetical conception, and as a consequence alongside the most industrious and painstaking work we often meet with hasty generalisations.

As stated at the beginning of this article, a sensational electrical experience, nearly 50 years ago, came under the observation of an eminent member of the engineering profession, and it was dealt with after the manner of the practical school, and, as a consequence, the world was put in possession of an altogether new type of machine very shortly afterwards. Faraday was also communicated with, and he dealt with it also in a similar way, investigating somewhat exhaustively what had been brought under his notice, and then, but *not* till then, a paper was read at the Royal Society and solid scientific progress was the immediate outcome.

History has to a certain extent repeated itself, and we have a very fair illustration of the different manner scientific questions are dealt with by the practical and by the theoretical schools. An accidentally performed and unrepeated experiment is brought under the notice of our greatest physicist and acknowledged chief of the theoretical school, but how differently is the matter dealt with to that we may be sure Faraday would have adopted. An unrepeated experiment of a startling character is hailed at once, apparently without any further experimental investigation being considered at all necessary, as a triumphant and conclusive demonstration of the truth of theory, and we shall all of us *now* be expected to accept as an oracular utterance what Sir William Thomson has somewhat sensationally given the sanction of his name to, for, as that popular scientific speaker the Chief Electrician of the Postal Telegraphs publicly stated not so long ago in respect to this supposed crowding of alternating currents in the outer skin of conductors, "When so great an authority as Sir William Thomson says it is so, who can doubt it."

THE JUBILEE OF THE PENNY POST.

THE exhibition held in the Guildhall on the 16th, 17th and 19th has been a very great success, the display having been visited by several thousand people. Commencing with a *soirée* on the 16th, the exhibition was kept open on the 17th and 19th from 10 a.m. to 10 p.m., and regrets were freely expressed, both personally and by the press, that such an interesting sight could not have been continued for a longer period. The Postal exhibit proper was very complete in all its details and excited great interest; but probably greater attention was given to the excellently arranged display of telegraphic apparatus, both historical and modern, the whole of the latter being kept in full working order during the time the exhibition was open. The large staff of telegraphic employés who had charge of the instruments had hard work in attending to the working of the apparatus and explaining to the very numerous visitors the action of the same. The circuits which attracted most attention were those worked by the Hughes type printer, direct communication being kept up with Paris and Berlin by means of the same. A multiplex set working six instruments to Brighton also received a great share of attention and worked without a hitch throughout. Several fast speed Wheatstone circuits, working to provincial towns, were much admired, and the employés working them had hard work in satisfying the very numerous applications for specimens of the perforated and printed "slip." The Direct Writer, Morse, Duplex, Single Needle, A.B.C., and other apparatus, all came in for a fair share of attention, and the display of historical apparatus, commencing with the Wheatstone 4-needle instrument of 1838, and the specimens of submarine cables, insulators, &c., used by the Post Office were the subjects of numerous enquiries.

ELECTRIC TANNING.

ON Wednesday, May 14th, the British Tanning Company, Limited, who own the British patents of MM. Worms and Balé, issued invitations to the members and press of the tanning, electrical, and allied trades, to inspect their works at Rothsay Street, Bermondsey, and see the process of rapid electric tanning in operation. A considerable party of visitors, numbering nearly a hundred, were present, including several well-known tanners. They were first shown a drum containing tan liquor of the required strength, into which a pack of Australian salted hides, unhaired and cleaned in the ordinary way, were put. The drums employed are 11 feet 6 inches in diameter by 8 feet wide, and contain an electrode running round the interior of one end or head, from which the current passes through the liquor to a similar conductor on the other head.

The drum was set in motion, and a current of 10 ampères passed through the liquor. The action of the current which is applied is partly *to promote diffusion* and partly *to electrolyse the liquor*, both these effects, aided by the rotation of the drum, are no doubt the explanation of the remarkable saving of time effected by this process, it being possible thus to tan skins and hides in from 24 to 144 hours, against four to 15 months by the old process of steeping in pits. A drum was opened which had been running for a little over five days, sections of the hides (salted Australian) were cut and examined by tanners present, and found to be thoroughly tanned. The visitors then inspected the drying sheds and shops above, where leather was seen in all stages, rolled for sole leather, curried, &c., also some hides prepared for machine belting, as, according to some tests shown us by Mr. Conrad Falkenstein, manager at Rothsay Street, the tensile strength before breaking, taking the average from a number of samples, was equivalent to 4,305 lbs. per square inch for the electrically tanned leather, against 3,570 to 3,800 for leather tanned by the ordinary process. The leather is now being sold in the market, and is steadily taking its place in every branch of the trade. The company has an exhibit at the Edinburgh Exhibition, where samples of rough and dressed leather tanned by this process are on view.

THE PARIS INTERNATIONAL TELEGRAPHIC CONFERENCE.

THE above Conference was duly opened on Friday last (that being the seventh time it has met), under the presidency of M. Jules Roche, Minister of Commerce.

In opening the Conference, M. JULES ROCHE delivered an excellent speech, which was really a history of telegraphy during nearly half a century. He mentioned, in the first place, that it was France which, in 1865, inaugurated these international reunions, and which created the telegraphic union, which, in succession, the whole of the peoples of the world had entered. Vienna in 1868, Rome in 1872, St. Petersburg in 1875, London in 1879, and Berlin in 1885 had been in turn the cities in which these telegraphic assemblies had been held, and each of them had brought forth fresh progress in the administrative working of this strange science, which was still so full of mystery, and yet already so fecund in services rendered to industry, commerce, and, further, to the general civilisation of humanity. To-day it was more than a half a milliard which the network of 223,000 kilomètres of submarine cables thrown to the bottoms of oceans represented. This network bore thought and human will from one end of the earth to the other with the rapidity of lightning. More than thirty-eight millions of telegrams were sent in France in a year, or a telegram per inhabitant; more than twenty-four millions in Germany, or a telegram per two inhabitants; more than sixty millions in England, or 1·58 telegram per inhabitant; or, for the

whole of the countries comprised in the telegraph union, more than 240 million telegrams, representing an expenditure of more than 300 million francs. M. Roche afterwards alluded to telephony, which was referred to for the first time at the Berlin Conference five years since, and with which the Paris Conference will, in its turn, occupy itself. According to M. Roche, it was a Frenchman, Charles Bourseul, a simple *employé* of the Posts and Telegraphs, who prophesied in 1854 that "speech would soon be transmitted to a distance by electricity." Graham Bell, Hughes, Edison, and so many other powerful and ingenious minds had, since 1877, conducted this admirable invention to the pitch of perfection which it has now attained. M. Roche, in conclusion, rendered an eloquent eulogium to the man who was the first to formulate the complete theory of telephony.

Mr. NIELSEN, director of the Norwegian Telegraph Administration, as *doyen* of the delegates, was selected to reply to M. Roche, in doing which he said there were, at that moment, two facts to which he desired to call attention: The first was that their union was the first international union which had affected a universal character; the second was that it was on the initiative of France that this union had been created. Ah, gentlemen, concluded M. Nielsen, France, after suffering from the richness of ideas which germinate in this land of liberty, asks nothing better than to offer to the world to share with her the good fruit of her progress and experience.

Herr HAKE, director of the German Telegraph Service, in the name of all the delegates, thanked the French Administration for the reception they had met with in Paris.

The voting takes place by nationality; the resolutions voted will not remain in the position of wishes expressed, but will become executive almost immediately. The Conference will last four weeks, during which only six plenary meetings will be held; but those meetings, which will begin in the morning, will be prolonged till the evening, and even into the night if that be necessary. All the sittings will be absolutely private. The questions treated, though very numerous, will not greatly interest the general public, for almost all are of an administrative nature. They may be divided into two series:—1. Questions relating to the regulations accepted by all the States belonging to the Telegraphic Union; 2. Questions relative to tariffs, for instance, the establishment of a single tariff for international telegraphy, the charging of dispatches according to the number of letters contained in the words, and not according to the number of words, some being short and some long, &c.

A telegraphic conference, says the *Independence Belge*, met in Paris on May 15th. It appears that the German delegates will propose thereat the reduction to 10 pfennings (1·5d.) of the transmission price per word of all the dispatches exchanged between Germany, Austria, France, England, Belgium, and Holland. This proposition will almost certainly be supported by the representatives of Great Britain. In the country of the "penny postage" high prices for posts and telegraphs have been done away with. The experiment of cheapness has been made a long time now. The lower the transmission price of letters and dispatches, the higher the receipts of the Post Office. The time is probably not far distant when it will only cost a penny to send a letter from London to Melbourne or Jamaica. Public opinion, moreover, gets ahead of the Government in its dreams of postal and telegraph reform. An eloquent Member of Parliament, who has devoted himself almost exclusively to these reforms, and who well interprets the general aspirations, Mr. Henniker Heaton, whom one might call the Cobden of cheap posts and telegraphs, will not be content with a reduction of the telegraphic rate to 12½ centimes. Thinking that the State should limit itself to the smallest possible profit, as the carrier of letters, newspapers, dispatches, &c., he protests against the sum of 2½d., which represents four times the cost of transmission of a telegram, and claims, with an energetic persistency, a still more considerable lowering of rates. Another of his ideas, concludes our contemporary, is that the State should become the "factor" nearly gratuitously of news destined for the press, news addressed to the public, and which represents a daily diffusion of light, indispensable to the intellectual, moral, and material well-being of the masses.

THE HALIFAX-BERMUDAS CABLE.

OUR readers are doubtlessly aware that the manufacture of this cable at the works of W. T. Henley Telegraph Company, North Woolwich, has been completed, and that it has been shipped on the ss. *Westmeath*, which was expected to proceed to sea yesterday.

Captain Stiffe, late of the Indian Marine, and for some time in charge of the Persian Gulf cables, directs the operations of laying on behalf of the contracting company, while Mr. R. E. Peake, of the firm of Clark, Forde and Taylor, accompanies the expedition as engineer on behalf of the Halifax and Bermudas Cable Company.

The Halifax and Bermudas Cable Company was incorporated under the Companies' Acts of 1882–1886, with a capital of £120,000 in 4½ per cent. first mortgage debentures, and £50,000 in ordinary shares of £5 paid in full.

We gather from the *Bermuda Royal Gazette* that Mr. Rippon has already completed all arrangements in Halifax for cable landing, underground connections and offices, and that the said gentleman is now engaged in carrying out the same dispositions at Hamilton, Bermudas.

The journal above mentioned informs us that after laying the shore end and intermediates, and buoying the latter at Halifax, the *Westmeath* will carefully sound the proposed route towards Bermuda. After landing the shore end at this place, she will pay out the intermediates and main cable towards Halifax, and make the final splice with the intermediate previously buoyed at that end.

Our contemporary expected that the section would be completed and opened to public service about the middle of June; but owing to unforeseen delays, the ship has not been able to leave the Thames at the date originally fixed upon. It seems probable that, provided no hitch takes place in the laying operations, the cable will not be completed until about the middle of July.

PROF. ELIHU THOMSON'S ELECTRO-MAGNETIC INDUCTION EXPERIMENTS.*

By J. A. FLEMING, M.A., D.Sc., M.I.E.E, Professor of Electrical Engineering in University College, London.

I. In the Paris Exhibition of 1889, and in the United States Court, many present will, perhaps, recollect to have seen a collection of electrical apparatus, contributed by Prof. Elihu Thomson as his private exhibit. These pieces of experimental apparatus constituted the appliances for illustrating some highly remarkable and interesting facts in electro-magnetic induction. It is more than probable that very many persons interested in electrical discovery either did not find, or did not happen to see in action, these instruments, or perhaps had not the opportunity to see them at all. By the kindness of Prof. Elihu Thomson, to whom I am indebted for the loan of the apparatus, it is in my power to repeat some of these experiments before you to-night; and my obligations are likewise especially due to Mr. Ernst Thurnauer, the engineer of the European Thomson-Houston Electric Light Company, for affording me his valuable aid in bringing them before you, and to Mr. Garfield, of the Thomson Electric Welding Company, for assistance in preparing the experiments. A few introductory remarks will be essential, in order that I may carry the whole of my audience with me in subsequent explanations; and these remarks will refer to that which is so very familiar a subject to every elec-

* Paper read before the Society of Arts, May 14th, 1890.

trician, viz., the mutual induction of electric circuits. Before me lies a very large bobbin, or spool, wound over with two insulated copper wires. These wires were wound on the spool together, and for convenience sake we will distinguish them by calling them A and B (fig. 1). Bear in mind that the wires or circuits are insulated from each other throughout their entire length, but lie closely adjacent on the bobbin. I can at pleasure insert a large bundle of soft iron wires tied up together into the hollow split brass tube which forms the body or the spool. The ends of one wire, say A, are connected to the terminals of a glow lamp, and I can pass or interrupt an electric current which traverses the other circuit, B, and a second glow lamp in series with it. You will note at once what happens when I start or stop the electric current in the circuit, B. The lamp connected to circuit A flashes up momentarily at the instant when the current begins to flow in circuit B, and also when it ceases to flow; but whilst the current flows steadily in the circuit B, and illuminates the lamp in series with it, the lamp in series with circuit A is not illuminated at all. We have here a lecture experiment illustrating the familiar classical discovery of Faraday of the mutual induction of two electric circuits, viz., that the starting or stopping of

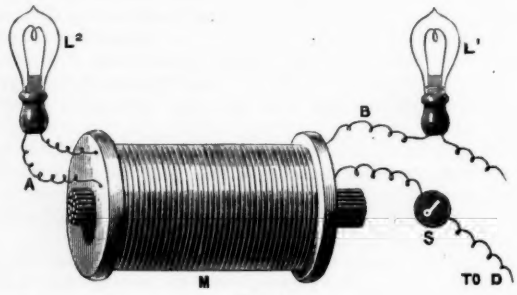


FIG. 1.

an electric current in one circuit induces at the instant of commencement or cessation a brief secondary current in another closed adjacent circuit. I shall not take up time by dwelling on the historical details of this fundamental fact. You know them well. If, instead of starting and stopping a continuously flowing electric current through the circuit, B, and observing at each "make" or "break" a brief secondary current in circuit, A, we supply the circuit, B, with an alternating electric current, one of which the direction is rapidly reversed many times in a second, and connect as before a glow lamp in series with circuit A, we find that this lamp glows continuously whilst the alternating current flows in circuit B. This also is familiar to us all. If in our first experiment we had employed, as a current detector in the secondary circuit, not an incandescent lamp, but some kind of galvanometer capable of indicating the direction of the induced electric current, we could easily have established for ourselves the fact that at the instant when the continuous electric current begins to flow in the circuit, B, it generates an oppositely directed induced secondary current in the circuit, A, which is merely transient current. At the instant when the continuous current is interrupted in circuit, B, it gives rise to a similarly directed transient induced electric current in the circuit, A. The momentary currents in A are called the *inverse* and *direct* secondary currents, induced by the commencement or cessation of the continuous primary current in circuit B. If the primary current is rapidly reversed, as in the case of an alternating current, then the secondary current consists likewise of a

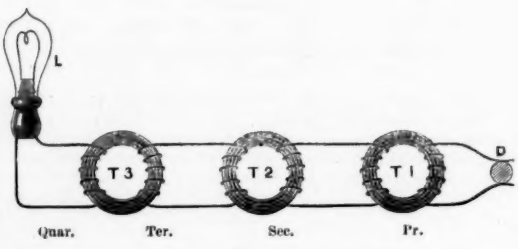


FIG. 2.

rapid succession of currents alternating in direction. In most of our experiments this evening we shall employ an alternating current, having a "frequency" of 90 per second—that is to say, changed in direction in the circuit 180 times in a second, and provided for us by the kindness of the London Electric Supply Corporation. If such an alternating current traverses a primary circuit, it induces a secondary alternating current of the same frequency in an adjacent secondary circuit, and this secondary periodic current may be made to induce in another circuit a tertiary current of like frequency, and this, again, a quaternary current, and so on; these successive orders of induced currents being, as it were, the children, grandchildren, and great-grandchildren of the primary parent current to which they owe their birth (Fig. 2).

The same large spool of insulated wire will provide us with the means of illustrating another important fact. I join up the two wires, A and B, into one length, so as to form one continuous bobbin of wire, and connect this great spiral of wire with a couple of glow lamps, one being in series with the wire spiral, and the other being parallel with it (fig. 3, p. 628). On sending a steady current through the system, it divides between the wire spiral, S, and the lamp, L^1, and I adjust the strength of this current so that the lamp, L^1, is barely visibly red hot. On interrupting suddenly this electric current, the lamp, L^1, flashes up for a moment. We recognise that we have here to consider an inertia effect familiar to us as the effect of "self-induction" in the long coil of wire. Audiences in this room have been so carefully informed on many past occasions by brilliant and capable teachers, that I may spare you a reiteration of elementary facts concerning the self-induction or inductance of conducting circuits, and take it for granted that everyone here is intimately acquainted with them, and that you

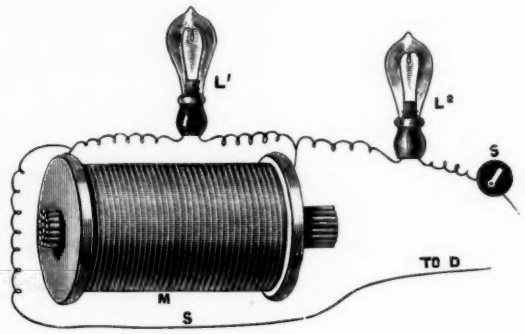


FIG. 3.

will recall to your recollection that when an electromotive force acts upon any closed electric circuit generating in it an electrical current, this self-induction exhibits itself by delaying or retarding the rise of the current strength to its full or its maximum value; and that, similarly, when the electromotive force is withdrawn, it operates to give the current a persistance, or to retard the rate of reduction of the current strength. The convenient term "time-constant" of a circuit is employed to denote that time, expressed in fractions of a second or any other unit, which must elapse before a current rises to a certain definite fraction of its full value, when a steady electromotive force acts upon that circuit. I will next beg you to turn a moment's attention to the electro-dynamic actions or forces which are brought into play when a circuit of any kind is subjected to electro-magnetic induction in a magnetic field. Consider, for instance, a ring of copper hanging in front of the pole of an electro-magnet (fig. 4), having the plane of the ring perpendicular to the lines of magnetic force proceeding out from the pole. Let the magnet be an electro-magnet, and let the pole be suddenly made a north or marked pole. Lines of magnetic force are thrust into the aperture of the ring. This magnetic flux, in accordance with a well-known law, generates an inductive electromotive force which causes a transient current to flow round the ring in a counter clockwise direction, as looked at *from* the north magnetic pole. The ring becomes virtually a

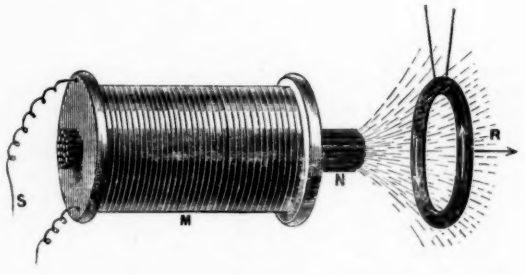


FIG. 4.

magnetic shell, having a north pole facing the north pole of the exciting magnet. By the fundamental laws of action between currents and magnets established by Ampère, the ring experiences a slight repulsive force, due to the electro-dynamic action between the current in the ring and the magnetic pole. The generation of the momentary induced current in the ring is accompanied by an electro-dynamic impulse tending to thrust it away from the pole. Suppose, next, that the electro-magnet is demagnetised. The ring has generated in it a reverse induced current flowing in the same direction as the hands of a clock move when looked at from the magnetic pole. This is also accompanied by an electro-

dynamic attraction of the ring towards the pole, but which is much more feeble than the previous repulsion. These attractions and repulsions are well seen when small discs of copper or aluminium are suspended in front of the poles of a powerful electro-magnet, which is alternately "made" and "broken." They have been particularly investigated by Mr. C. V. Boys.*

I will now ask you to consider what would happen if the coils of the electro-magnet were traversed by an alternating current? Furthermore, we shall first suppose that the copper ring has a zero time-constant, that is to say, the induced currents in the ring rise up and sink down in strength in exact synchronism with the changes in the inductive electromotive force acting on the ring. If the current flowing in the coils of the electro-magnet is represented as to changes in strength by a simple periodic curve, we may suppose that the magnetism of the core and the magnetic induction through the ring follow a similar law. It is very easy, then, to show that the induced electromotive force acting in the ring circuit, and hence the current in the ring, follows a similar law of fluctuation, but that the instant of maximum current in the ring coincides with the instant of reversal of magnetism in the electro-magnet. Under these circumstances we can represent the changing strength of the magnetic field in which the ring is immersed by a simple periodic curve, M, and the changes of current strength in the ring circuit by another simple periodic curve, C, shifted backwards relatively to the first by a quarter of a wave length (fig. 5).

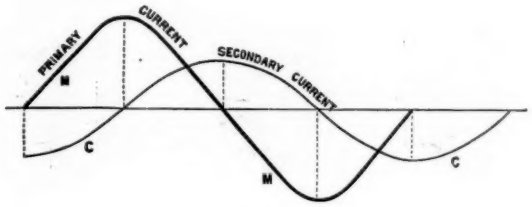


FIG. 5.

By Ampère's law, the force acting on the ring at any instant is proportional to the product of the instantaneous value of the surrounding field and this current strength. If we multiply together the ordinates of these two curves, M and C, and form a third curve, P, whose ordinate at every point is proportional to the product of the ordinates of the other curves (fig. 6) at those points, we obtain

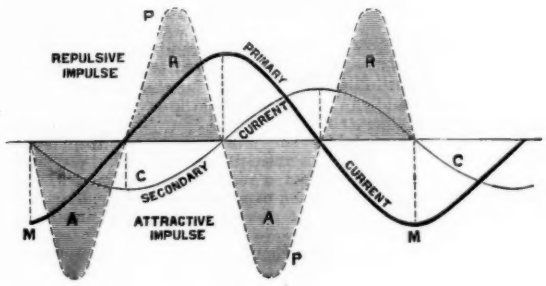


FIG. 6.

a curve which represents the fluctuation of force at every instant acting upon the ring. This curve, P, is also a wave-like curve, lying symmetrically above and below the horizontal line. The positive and negative areas of this curve included between the curve and the horizontal line represent the impulses or time integrals of the forces which act upon the ring. These impulses are alternately positive and negative. This is equivalent to saying that under the circumstances assumed the ring gets a series of small pushes and pulls, or repulsions and attraction, which succeed each other at the same rate as the changes of magnetic polarity of the magnet. The series of rapidly alternating and equal impulses would result in leaving the ring apparently unmoved. No real conducting ring can, however, behave in this fashion, because every ring has a sensible "time-constant." Let us next see how the above statements will be modified if the ring has such a sensible self-induction that the current induced in the ring lags behind the inducing electromotive force in phase. Repeating the above construction for a force curve, on the assumption that the instant of maximum of the current in the ring occurs later than the instant of reversal of magnetism in the magnet, it is easy to see that the force curve consists now of two very unequal parts. It is not symmetrically situated with respect to the horizontal lines (see fig. 7). The area of the hummocks (shaded portions) which lie above the datum line, and which represent the repulsive impulses on the ring, are much larger than the area of the hummocks below the datum line, and which represent the attractive impulses acting on the ring. This means to say, that the ring

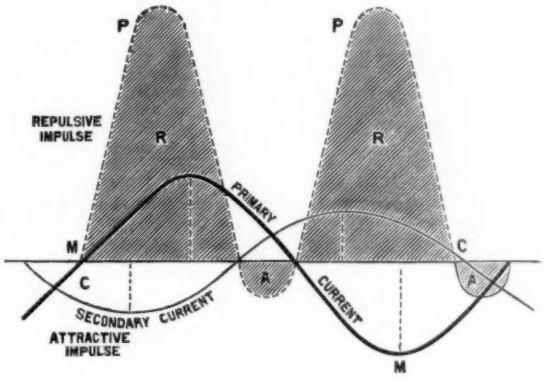


FIG. 7.

when possessing self-induction experiences on the whole a repulsive force, or a series of repulsive impulses, when immersed in such an alternating magnetic field radiated from a magnetic pole; and this repulsive force will be, within certain limits, more pronounced, other things being equal, the greater the time-constant of the circuit. You see clearly, therefore, that a ring or disc of copper in which the induced currents lag behind the inducing electromotive force in phase must experience a repulsive force when this inducing electromotive force is caused by a rapid flux backwards and forwards of lines of magnetic forces perforating through the ring or disc. The realisation of this inference in a striking manner is the first of a series of remarkable experiments on this subject due to Prof. Elihu Thomson. We have on the table an electro-magnet suitable for these experiments, which consists of a core of divided iron, surrounded by a coil in which I can cause to circulate a powerful alternating current of 40 to 50 ampères. Let us, however, begin with an experiment in which we employ a continuous current to energise the core. I give you, in Prof. Elihu Thomson's own words,* an account of this preliminary experiment:—

"In 1884, while preparing for the International Electrical Exhibition at Philadelphia, we had occasion to construct a large electro-magnet, the cores of which were about 6 inches in diameter and about 20 inches long. They were made of bundles of iron rod about $\frac{5}{16}$ths of an inch in diameter. When complete, the magnet was energised by a current from a continuous-current dynamo, and it exhibited the usual powerful magnetic effects. It was found also that a disc of sheet copper of about $\frac{1}{16}$th of an inch in thickness, and 10 inches in diameter, if dropped flat against a pole of the magnet, would settle down softly upon it, being retarded by the development of currents in the disc, due to its movement in a strong magnetic field, and which currents were of opposite direction to those in the coils of the magnet. In fact, it was impossible to strike the magnet pole a sharp blow with the disc, even when the attempt was made by holding one edge of the disc in the hand, and bringing it down forcibly towards

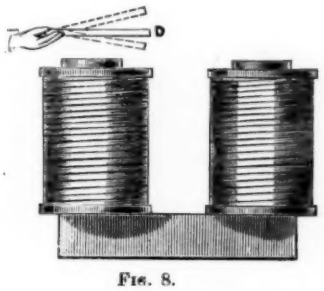


FIG. 8.

FIG. 9.

the magnet. In attempting to raise the disc quickly off the pole, a similar but opposite action of resistance to movement took place, showing the development of currents in the same direction as those in the coils of the magnet, and which currents, of course, would cause attraction as a result. The experiment could be tried in another way. Holding the sheet of copper by one edge, just over the magnet pole (fig. 8), the current in the magnet coils was cut off by shunting them. There was felt an attraction of the disc, or a dip towards the pole.

* On a "Magneto-Electric Phenomenon." By C. V. Boys, F.R.S. Proc. Phys. Soc., London, Vol. vi., page 218.

* See the *Electrical World*, May, 1887, p. 258; or the *Electrical Engineer* (American), June, 1887, p. 211:—"Novel Phenomena of Alternating Currents," by Elihu Thomson.

The current was then put on by opening the shunting switch, and a repulsive action or lift of the disc was felt. The actions just described are what would be expected in such a case, for when attraction took place currents had been induced in the disc in the same direction as those in the magnet coils beneath it, and when repulsion took place the induced current in the disc was of opposite character or direction to that in the coils. Now let us imagine the current in the magnet coils to be not only cut off, but reversed back and forth. For the reasons just given, we find that the disc is attracted and repelled alternately; for whenever the currents induced in it are of the same direction with those in the inducing or magnet coil, attraction will ensue, and when they are opposite in direction repulsion will be produced. Moreover, the repulsion will be produced when the current in the magnet coil is rising to a maximum in either direction, and attraction will be the result when the current of either direction is falling to zero, since in the former case opposite currents are induced in the disc, in accordance with well-known laws; and in the latter case currents of the same direction will exist in the disc and the magnet coil. The disc might, of course, be replaced by a ring of copper or other good conductor, or by a closed coil of bare or insulated wire, or by a series of discs, rings, or coils superposed, and the results would be the same."

We have already seen that in an alternating field the electro-dynamic impulses so experienced by the disc or ring are alternately attractive and impulsive, and that when the circuit possesses a sensible self-induction, the repulsive impulses overpower the attractive ones, and their repetition constitutes a repulsive force. Before adding a few more words of explanation, permit me to show you some of these electro-dynamic repulsions produced by an alternating electro-magnet. Here is a copper ring, and I lay it upon the top of this electro-magnet, having a divided iron core and excited by a powerful alternating current. On energising the magnet, the ring jumps up in the air (fig. 9). If a copper plate is hung like a scale pan from a balanced beam, and placed over the magnetic pole, it gives evidence of being strongly repelled the moment we pass the current through the coils of the

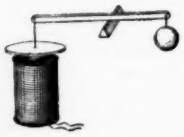


FIG. 10.

magnet (fig. 10). Instead of employing copper rings or copper plates, we can use closed coils of thick wire, either insulated or not. If, however, our plates or rings have a radial slit made in them, or if our coils of wire are not closed-circuit coils, all the effects vanish.

So strong is this repulsion, with proper appliances, that light copper rings tethered by strings may be held suspended in the air against the force of gravity, the upward electro-magnetic repulsion overcoming their weight, and holding them, like Mahomet's fabled coffin, floating in the air (fig. 11). In cases

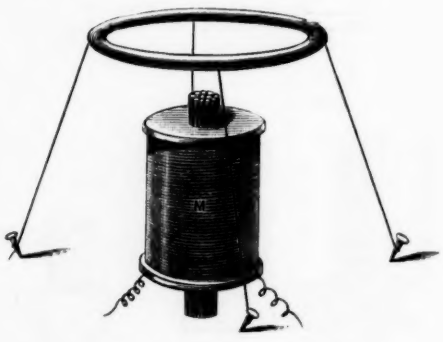


FIG. 11.

where we are dealing only with impulsive effects, aluminium rings or discs give most marked results, because aluminium has the highest conductivity per unit of mass; but in the cases like those just considered, where what is required is the greatest force effect, copper or silver gives a better result than aluminium, because they have the highest conductivity per unit of volume. In Mr. Boys's experiments, if I remember rightly, he found aluminium the best to employ. In these cases of electro-dynamic repulsion, the force effect depends essentially upon the lag of the induced current, or its retardation in phase behind that of the inducing field, and, other things being equal, this is proportional to the conductivity of the circuit. I will pass before your view a series of diagrams intended to represent various cases and modes of production of these repulsive effects, giving you descriptions of them in Prof. Elihu Thomson's own words. He says:

"This preponderating repulsive effect may be utilised or may show its presence by producing movement or pressure in a given direction, by producing angular deflection as of a pivoted body, or by producing continuous rotation in a properly organised structure.

"In fig. 12, C is a coil traversed by alternating currents, B is a copper case or tube surrounding it, but not exactly over its centre. The copper tube, B, is fairly massive, and is the seat of heavy induced currents. There is a preponderance of repulsive action tending to force the two conductors apart in an axial line. The part B may be replaced by concentric tubes slid one in the other, or by a pile of flat rings, or by a closed coil of coarse or fine wire, insulated or not. If the coil, C, or primary coil, is provided with an iron core, such as a bundle of fine iron wires, the effects are greatly increased in intensity, and the repulsion with a strong primary current may become quite vigorous, many pounds of thrust being producible by apparatus of quite moderate size.

"The forms and relations between the two parts, C and B, may be greatly modified, with the general result of a preponderance of repulsive action when the alternating currents circulate.

"Fig. 13 shows the part, B, of an internally tapered or coned form, and, C, of an externally coned form, wound on an iron wire bundle, I. The action in fig. 12 may be said to be analogous to that of a plain solenoid with its core, except that repulsion, and not attraction, is produced; while that of fig. 13 is more like the

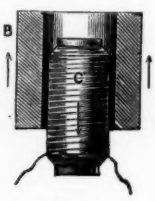


FIG. 12.

FIG. 13.

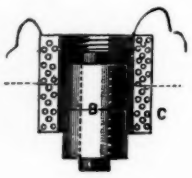


FIG. 14.

action of tapered or conically-wound solenoids and taper cores. Of course, it is unnecessary that both be tapered. The effect of such shaping is simply to modify the range of action and the amount of repulsive effort existing at different parts of the range.

"In fig. 14 the arrangement is modified so that the coil, C, is outside, and the closed band or circuit, B, inside and around the core, I. Electro-inductive repulsion is produced as before.

"It will be evident that the repulsive actions will not be mechanically manifested by axial movement or effort, when the electrical middles of the coils or circuits are coincident. In cylindrical coils, in which the current is uniformly distributed through all the parts of the conductor section, what I here term the electrical middle, or the centre of gravity of the ampère-turns of the coils, will be the plane at right angles to its axis at its middle, that of B and C in fig. 14 being indicated by a dotted line. To repeat, then, when the centres or centre planes of the conductors (fig. 14) coincide, no indication of electro-inductive repulsion is given, because it is mutually balanced in all directions; but when the coils are displaced a repulsion is manifested, which reaches a maximum at a position depending on the peculiarities of proportion and distribution of current at any time in the two circuits or conductors.

"In fig. 15, B represents a copper ring, and C an annular coil

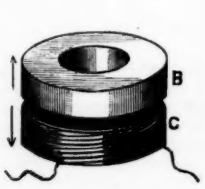


FIG. 15.

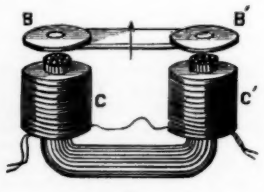


FIG. 16.

placed parallel thereto; and an iron core or wire bundle placed in the common axis of the two coils, shows the repulsive action when an alternating current is passed through C. B may be simply a disc or plate of any form, without greatly affecting the nature of the action produced. It may also be composed of a pile of copper washers or a coil of wire, as before indicated.

"An arrangement of parts somewhat analogous to that of a horseshoe electro-magnetic and armature is shown in fig. 16. The alternating current coils, C, C', are wound upon an iron wire bundle bent into U-form, and opposite its poles is placed a pair of thick copper discs, B, B', which are attracted and repelled, but with an excess of repulsion depending on their form, thickness, &c.

"If the iron core takes the form of that shown by I, I, fig. 17 (p. 634), such as a cut ring with the coil, C, wound thereon, the insertion of a heavy copper plate, B, into the slot or divided portion of the ring, will be opposed by a repulsive effort when alternating

currents pass in C. This was the first form of device in which I noticed the phenomenon of repulsive preponderance in question. The tendency is to thrust the plate, B, out of the slot in the ring, excepting only when its centre is coincident with the magnetic axis joining the poles of the ring between which B is placed.

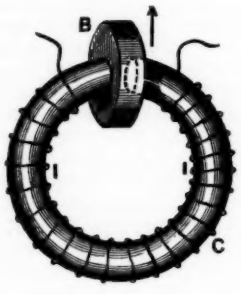


FIG. 17.

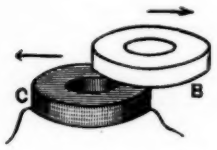
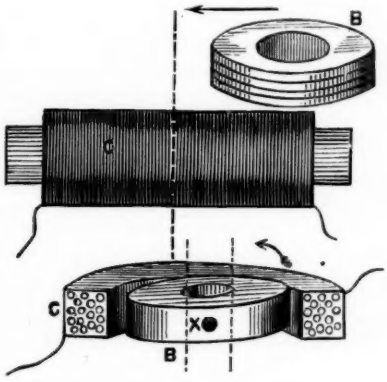


FIG. 18.

"If the axes of the conductors (fig. 15) are not coincident, but displaced, as in fig. 18, then, besides a simple repulsion apart, there is a lateral component or tendency, as indicated by the arrows. Akin to this is the experiment illustrated in fig. 19. Here the closed conductor, B, is placed with its plane at right angles to that of C, wound on a wire bundle. The part, B, tends to move toward the centre of the coil, C, so that its axis will be in the middle plane of C, traverse to the core, as indicated by the dotted line. This leads us at once to another class of actions, *i.e.*, deflective actions.



FIGS. 19 and 20.

"When one of the conductors, as B (fig. 20), is composed of a disc or, better, of a pile of thin copper discs, or of a closed coil of wire, is mounted on an axis, X, transverse to the axis of coil, C, through which coil the alternating current passes, a deflection of B to the position indicated by dotted lines will take place, unless the plane of B is at the start exactly coincident with that of C. If slightly inclined at the start, deflection will be caused as stated. It matters not whether the coil, C, incloses the part, B, or be inclosed by it, or whether the coil, C, be pivoted, and B fixed, or both be pivoted. In fig. 21 the coil, C, surrounds an iron wire core, and B is pivoted above it, as shown. It is deflected, as before, to the position indicated in dotted lines.*

"It is important to remark here that, in cases where deflection is to be obtained, as in figs. 20 and 21, it had best be made of a pile of thin washers or a closed coil of insulated wire, instead of a solid ring. This avoids the lessening of effect which would come from the induction of currents in the ring B, in other directions than parallel to its circumference."

Returning for a moment to the theory of these repulsive and deflective actions, it will repay us to consider it in the form placed before us by Prof. Thomson, in his first paper on the subject, read before the American Institute of Electrical Engineers, May 18th, 1887. He says:—"It may be stated as certainly true that, were the induced currents in the closed conductor unaffected by any self-induction, the only phenomena exhibited would be alternate

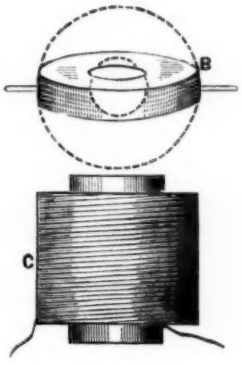


FIG. 21.

equal attractions and repulsions, because currents would be induced in opposite directions to that of the primary current when the latter current was changing from zero to maximum positive or negative current, so producing repulsion; and would be induced in the same direction when changing from maximum positive or negative value to zero, so producing attraction.

"This condition can be illustrated by a diagram, fig. 22. Here the lines of zero current are the horizontal straight lines. The

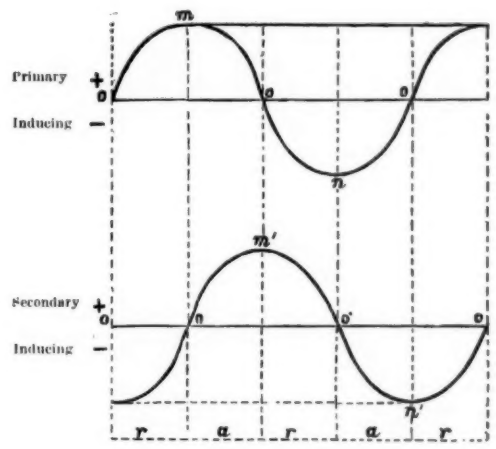


FIG. 22.

wavy lines represent the variations of current strength in each conductor, the current in one direction being indicated by that portion of the curve above the zero line, and in the other direction by that portion below it. The vertical dotted lines simply mark off corresponding portions of phase or succession of times.

"Here it will be seen that in the positive primary current descending from M, its maximum, to the zero line, the secondary current has risen from zero to M', its maximum. Attraction will therefore ensue, for the currents are in the same direction in the two conductors. When the primary current increases from zero to its negative maximum, N, the positive current in the secondary closed circuit will be decreasing from M', its positive maximum, to zero; but, as the currents are in opposite directions, repulsion will occur. These actions of attraction and repulsion will be reproduced continually, there being a repulsion, then an attraction, then a repulsion, and again an attraction, during one complete wave of the primary current. The letters, R, A, at the foot of the diagram, fig. 22, indicate this succession. (The shaded portions in the diagrams represent the time during which the force between the primary and secondary circuits is a repulsive force.)

"In reality, however, the effects of self-induction in causing a lag, shift, or retardation of phase in the secondary current, will considerably modify the results, and especially so when the secondary conductor is constructed so as to give to such self-induction a large value. In other words, the maxima of the primary or inducing current will no longer be found coincident with the zero points of the secondary currents. The effect will be the same as if the line representing the wave of the secondary current in fig. 22 had been shifted forward to a greater or less extent. This is

* This deflection by an alternating current of a copper disc suspended within a coil with its plane inclined to the plane of the coils, I myself noticed independently, in March, 1887, and subsequently described a copper disc galvanoscope for alternating currents, based on this fact (see the *Electrician*, May 6th, 1887). I did not, at the time, know how thoroughly Prof. Thomson had explored the phenomena, but the substantial explanation of it had already occurred to me.

indicated in diagram, fig. 23. It gives, doubtless, an exaggerated view of the action, though from the effects of repulsion which I have produced I should say it is by no means an unrealisable condition.

"It will be noticed that the period during which the currents are opposite, and during which repulsion can take place, is lengthened at the expense of the period during which the currents are in the right direction for attractive action. These differing periods are marked *r*, *a*, &c., or the period during which repulsion exists is from the zero of the primary or inducing current to the succeeding zero of the secondary or induced current; and the period during which attraction exists is from the zero of the induced current to the zero of inducing current. (It will be seen that the shaded portions in diagram 23 have been widened out at the expense of the unshaded parts.)

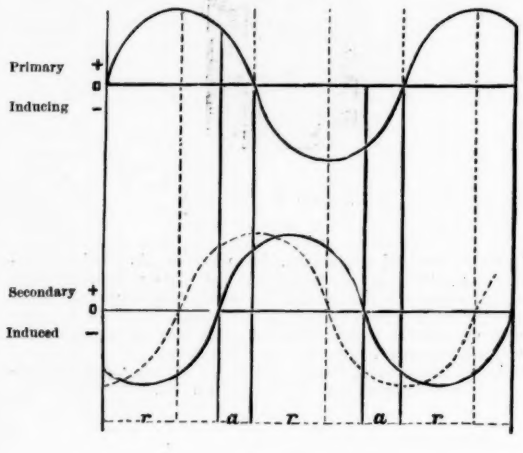


FIG. 23.

"But far more important still in giving prominence to the repulsive effect than this difference of effective period, is the fact that during the period of repulsion both the inducing and induced currents have their greatest values, while during the period of attraction the currents are of small amounts comparatively. This condition may be otherwise expressed by saying that the period during which repulsion occurs includes all the maxima of current, while the period of attraction includes no maxima. There is then a repulsion due to the summative effects of strong opposite currents for a lengthened period against an attraction due to the summative effects of weak currents of the same direction during a shortened period, the resultant effect being a greatly preponderating repulsion.

"It is now not difficult to understand all the actions before described, as obtained with the varied relations of coils, magnetic fields, and closed circuits. It will be easily understood, also, that an alternating magnetic field is in all respects the same as an alternating current coil in producing repulsion on the closed conductor, because the repulsions between the two conductors are the result of magnetic repulsions arising from opposing fields produced by the coils when the currents are of opposite directions in them."

(To be continued.)

Lighting at Southend.—The Southend Local Board, by a majority of one, has decided to erect works for electric lighting and traction at the new pier. Messrs. Crompton have already placed an estimate for the works with the board, which works, the chairman estimates will involve an expenditure of about £5,500, or an annual charge of £550, which, with the cost of working, would bring the total cost to £900 per year, and he has informed the board that, as a result of a visit to Chelmsford, he is of opinion that the previous street illumination by gas was infinitely superior to the electric lighting now supplied by Messrs. Crompton. That opinion, however, did not result, as was anticipated, in the adoption of gas. As for the cost, Mr. Watson Smith, who resides at Southend, and who is a representative of Messrs. E. P. Elieson and Smith, has informed the board, as a ratepayer, that Messrs. Crompton's tender is "outrageously high," and in consequence of this the board has not yet decided what steps to take in carrying the resolution into effect. It may be mentioned that Messrs. Crompton's tender was £4,600 without the extras or engineers' commissions.

NOTES.

Bromley Lighting.—The movement for the lighting of Bromley by electricity is making rapid and satisfactory progress. Mr. John Wright, A.M.I.E.E., representative of the firm of Messrs. Laing, Wharton and Down, of New Bond Street, has attended a conference, at which he advocated the Thomson-Houston system, for which he claimed a dividend of at least from 12 to 14 per cent. would be returned if the investment was made. Mr. Wright disclaimed that electric lighting was an enemy to gas. He advocated an overhead system of wires, and said that the joint opinion of Sir Richard Webster, Attorney-General, Mr. J. Fletcher Moulton, Q.C., and Mr. R. S. Wright, were unanimous upon the power of any company or syndicate to run overhead wires without infringing the Electric Lighting Act. He estimated the cost of installation suitable for Bromley, at £6,500 for 800 incandescents and 50 arcs, or £7,800 for 1,000 incandescents and 100 arcs; but it was resolved that he should go further into the matter and present a report containing details as to cost and construction to the committee. As to the saving over gas there can be no doubt. Gas at Bromley is 3s. per 1,000, and Mr. Podgers, who has adopted the electric light at his works, after making careful calculations, says that for 1s. 2d. he gets the same amount of light, with more comfort and cleanliness, than he formerly did for an expenditure of 3s. in gas.

The Electric Light at Port Said.—A Foreign Office report states that this year the electric light is to be used at Port Said for a very large house being built by a British firm.

Obituary.—The death is announced of Mr. Carl Frischen, of Messers. Siemens and Halske, at the age of 60. He commenced life as a telegraph engineer and after having been engaged on railway telegraphs in Hanover, he was made chief of the Hanoverian telegraphs. In 1867 he was engaged on the North German Confederation telegraphs, and three years later joined Messrs. Siemens and Halske as chief engineer.

American scientific circles has sustained a severe loss in the death of Major Otto E. Michaelis. The deceased served with great distinction in the civil war, but was better known as one of the founders of the American Institute of Electrical Engineers, and has always taken the keenest interest in its welfare.

Telegraph in East Africa.—The Germans intend to establish telegraphic communication between their military stations in East Africa, and specially trained non-commissioned officers are to be sent to Major Wissman from the Fatherland to carry out the necessary work.

The Electric Light in Brussels.—The Electricity Commission of the City of Brussels last Friday finished the examination of the specifications for the electric lighting of that city. All the proposed systems will be required to compete for the lighting of the whole city, and the commission has discarded the idea of dividing the concession into two as was originally proposed. The systems which have been under consideration are five in number, and are based:—1. On direct distribution and at low tension; 2. On high tension by alternating currents; 3. On high tension by continuous currents and with accumulators; 4. On distribution by compressed air; 5. On distribution by water at high pressure. It is probable that the concessionary will use more than one of these systems according to the exigencies of the working, as is done at Paris, where the municipality makes use of both low tension and of alternating currents for the more remote places.

A Mystery.—The only new electrical company registered this week bears a curious title. What a string of possibilities lie hidden under the business carried on by three of the signatories!

Last Week's Storms.—The following occurred in the Manchester *Courier* :—"At Ashton-under-Lyne a peculiar incident was witnessed. The electric fluid ran down the conductor of the large chimney stack belonging to the Hurst Mills Company, Limited. There is a tank at the bottom of the chimney, in which the end of the wire is inserted, presumably to smother the electric fluid, and this being empty the lightning struck the ground, and by some means got into the gas main which is under the flags, bursting the pipes with a terrific explosion, and lifting half a dozen immense flags clean out of their places. The flames rose to a height of five or six yards. Travelling underground the current burst the pipe at a place about 20 yards down Queen Street, causing great alarm in the neighbourhood. In a house close to where the last explosion took place, where the toll-keeper, John Whitehead, and his wife lived, the gas entered from the burst main in immense volumes. On the old man going into the pantry with a lighted candle another loud explosion occurred, and Whitehead and his wife were rendered unconscious. The old lady recovered in the afternoon of Tuesday, and the man remained unconscious the whole of that day. As the gas works are within a few yards of where the explosion took place, the occurrence might have been of a much more serious nature."

Vienna Lighting.—The works for lighting the Prater by electricity have commenced and are in active progress.

Paris Lighting.—M. Comboul's gigantic installation for lighting the Gran Plaza de Toros in the Bois de Boulogne is complete. The evening performances now take place in the light of 20,000 carcels.

Personal.—Mr. J. W. Howard, who so skilfully manipulated the graphophone at the Bath meeting of the British Association, and afterwards at 10, Hatton Garden, and in many other places, we hear, left England yesterday by the Cunard ss. *Cephalonia* for Boston, where he is about to join his brother, Mr. Henry Howard, as partner in business as electrical power plant contractors. His recently made, but nevertheless extensive circle of friends here, will regret to lose him, but he takes with him its best wishes for success in his new venture.

H.M.T.S. "Monarch." — This cable-repairing ship, belonging to the Post Office Telegraphs, steamed down the Thames on Saturday on her way for the northern extremity of the Shetlands, where she will repair the two cables about which Mr. Lyall questioned the Postmaster-General on the 12th instant.

The Royal Society.—Yesterday the following paper was announced for reading :—"On a Method of Determining the Value of Rapid Variations of a Difference of Potential by means of the Capillary Electrometer," by G. T. Burch.

Electrical Fittings.—Some excellent specimens of artistic electrical fittings in hammered iron and brass work produced by craftsmen are on view at the exhibition held this week by the Armourers and Braziers Company at their hall in the City. Strange to say, this company used to possess absolute control over the production and sale within five miles of the City of London of all arms, armour, and hammered brass and copper work ; but, fortunately for the electrical trades, these powers have now ceased. The electrical exhibits comprise pendants, brackets, electroliers in nickel and lacquered brass, and in brass and copper, &c. Messrs. B. Verity and Sons show a small loan collection of art brass work. The exhibition closes to-morrow.

Erratum.—In our leading article on "Ozone" last week, the words "sterilising apparatus" should read *dialysing apparatus*.

Dr. Herz.—The plot to murder Dr. Cornelius Herz, the well-known electrician, was, says the *Daily News* Paris correspondent, the chief topic of conversation at his *soirée*, given to the members of the Telegraphic Convention on Tuesday last. It has been ascribed to anti-semitic fanaticism. Another suggestion was that a fanatical Boulangist was the author of the plot, Dr. Herz having lately ceased to befriend the General. At any rate, continues the correspondent, the revelations made in *La France* are found to be genuine. The person making them, one "Amiel," states that he read in the *Figaro* an advertisement offering a sum of money to any person who would carry out a dangerous and delicate enterprise. This he answered, and he was asked to rid the world of Dr. Herz. He took all the money he could get, and emigrated with his wife to Buenos Ayres. It seems, however, that Dr. Herz had not one but several narrow escapes from poisoning when Amiel, according to his own account, was in South America. [General Boulanger must indeed be in sore straits if anything the worthy doctor can do or say makes any difference to his condition.]

Electric Railways in the States.—Milwaukee, Wis., will be a perfect network of electric railways when the systems are all changed and the new lines completed.

A New Gas Syndicate.—A story comes from Philadelphia of an immense syndicate which is being formed to control the gas companies of Europe and America. The leading gas companies appear to be in favour of the scheme.

The International Telegraph Conference. — Reuter telegraphs : — Paris, May 20th : — The German and French propositions on the question of tariff modifications have been postponed until next Conference.

The Transmission of Power by Electricity. — The Committee of the Frankfort Exhibition of 1891 proposes to make the electrical transmission of motive power the principal feature of the show. This, it is thought, will give a fillip to the smaller industries which are now seriously handicapped by the use of steam motive power, and it will also do something to discourage what our contemporary *L'Electricien* calls the "illogical system" of distribution by compressed air.

Capital v. Organised Labour.—The Pleasant Valley Electric Railroad Company, Pittsburg, Pa., discharged nine of the motor men for the offence of belonging to an assembly of the "Knights of Labour." Trouble is expected.

Only Fair.—At a recent meeting of the organising committee of the Frankfort International Exhibition it was resolved that, having regard to the expenses and sacrifices which electrical firms and houses taking part in exhibitions of this kind are put to, it is only just that they should be allowed to share in the profits of the undertaking.

Another Fatality.—It is said the electric light wires took another life last Saturday in New York. Bastino Ipoldo, while cleaning windows in the Broadway, touched a wire of the Illuminating Company, which proved to be improperly insulated. The powerful current passed through his body, and he dropped lifeless to the pavement.

The Telegraphists.—The serious and widespread dissatisfaction among this important class of men is to find vent ere long in a national conference to be held at Leicester. A large meeting was held in Manchester a few days ago for the purpose of discussing the position and electing delegates for the Leicester meeting.

The Electric and General Investment Company, Limited.—This company, of which prospectuses were issued this week, is intended to facilitate "the promotion and development of undertakings for electric lighting, traction, transmission of power, and for other industrial uses of electricity," and we might perhaps add, seeing that two of the directors are also connected with the Brush Electrical Engineering Company, Limited, especially to finance schemes in which that company is interested. This, however, would be only a natural consequence, and we see no objection thereto. There are, in addition to those indicated, independent directors on the board, so that should anything particularly good arise, the new company may avail itself of the opportunity of making profit out of it. The capital of the company is put at £200,000, and the extent of the present issue is but £100,000 in ordinary shares, and £500 in 100 founders' shares. This amount may strike some as being small for the purposes indicated, but we have reason to believe that the company is only intended to act as an intermediary one, as for instance, in aiding the holder of a concession to obtain the financial assistance necessary to the carrying out of his concession. The 10 per cent. first to be paid to the ordinary shares, before the founders derive benefit from the profits, looks tempting, but it must be borne in mind that it is not cumulative, so that if a very profitable year arises, and then a series of bad ones, the average dividend to the ordinary shareholders may be very small; perhaps, however, the reserve fund may be made to equalise them. As no promotion money will be paid, and as there is nothing to pay for such commodities as patents or goodwill, we do not (although such a company might in some cases be made a means of promoting bubble concerns) on the face of the prospectus see any objection to the scheme, and sincerely trust it may prove a decided advantage in helping forward the industry now showing such hopeful indications of a bright and successful future. We are informed that the present issue is fully subscribed.

Bright's Lightning Guard.—This apparatus, which is a combination of points and fine wire, is extensively employed by cable companies outside the Eastern Company, which naturally uses the apparatus devised by Mr. Saunders. Bright's instrument is fully described in Ternants "Les Telegraphes." Mr. Saunders, in the course of his remarks on Dr. Lodge's paper, said that it had frequently been observed that the wire on his guard was fused (mentioned as a proof of its efficiency), and this in itself shows the trouble it must give to someone in journeying down to the cable hut to replace the ruptured wire. The Bright guard appears, therefore, to have a great advantage in this respect, as no sooner does the deflagration of a wire take place, than another is automatically brought into circuit, which process goes on until the last of, say, eight wires is broken, and then the cable puts itself to earth.

Ulm Cathedral.—Electric lighting will be a prominent feature in the festivities with which it is proposed to celebrate the completion of the tower of Ulm Cathedral on 30th June next.

The Watkin Tower.—Wembley Park, the spot chosen for the erection of the Watkin Tower, is about two miles beyond Willesden, is charmingly situate, and easy of access.

Arc Lamps.—"There is no doubt a great future for this invention." So says the *Mechanical World* in an article on Saunderson's hydro-carbon arc lamp, but evidently our contemporary, like the *Electrical Engineer*, has not taken the trouble to investigate the matter or to see what has been done in this direction by previous inventors. A reference to our pages during the last two months would probably induce these estimable journals to modify their opinions.

New Catalogue.—Messrs. Nalder Bros. & Co. have favoured us with a copy of a revised and enlarged edition of their catalogue of electrical testing and measuring instruments. Its usefulness has been increased by a considerable addition to the illustrations, and as electrical and scientific apparatus are constantly being improved both in design and mechanical construction, all users of instruments should make themselves acquainted with the latest forms, as described in this list.

Auction.—The sale of the plant of the Schmidt-Douglas Company takes place on Tuesday and Wednesday, the 3rd and 4th of June.

Electro-Motor Running Works.—At the Heaton Works of Messrs. C. A. Parsons & Co., the whole of the machinery has now for some time past been run by an electro-motor, the current for the latter being obtained from dynamo machines and engines that are running for test purposes, and the exhaust steam of which is employed to heat the shops. The economy of this arrangement is obvious.

Honours.—Mr. H. Trueman Wood, the well-known Secretary of the Society of Arts, has been created Knight. We congratulate the recipient of this honour, as every true man would.

Purchase of Business.—Messrs. Appleton, Burbey and Williamson inform us that they have purchased the manufacturing business of Mr. F. Geere Howard, of Cleveland Street, Fitzroy Square, and have transferred the plant to their premises at Hatton Garden.

Water Power for Central Stations.—The paper read at the Institution of Civil Engineers on Tuesday last, on "The Keswick Water-Power Electric Light Station," would have been of real value had it been accompanied by figures concerning the prime cost of the installation. Whatever the aims of the joint authors may have been, they in no way convinced their audience that electric lighting by water is more economical than electric lighting by steam-power, and this question was raised during the discussion, a reply to which could not be obtained owing to the lateness of the hour, the meeting having been adjourned, and all further discussion on the subject of the paper closed. To the chagrin of many present, most of the time was taken up by Mr. Gisbert Kapp, who, at the instigation of the President, gave the history of, and an elementary discourse on, transformers in a manner suitable for small boys who have never heard of the subject. Mr. Mordey followed with a description of another water-power plant, and, like Mr. Kapp, ventilated some of his own favourite notions about alternators and transformers, so that there was really no opportunity of anyone else speaking at length on the main question forming the basis of the paper; and as this was the last ordinary meeting of the session, we are deprived of further information on the subject, so far as the Institution of Civil Engineers is concerned. The matter is a very important one, and we hope to deal with it seriously at an early opportunity, and we can only express our regret to-day that the short time at the disposal of the last meeting was taken up with so much that was useless.

Bumbledom in Paris.—Our lively neighbours on the Continent, in the shape of the Paris Town Council, have a violent fit of protection, free trade in electrical machines is, it appears, to be sternly repressed, and nothing but machines made in France are to be used—this irrespective of their suitable qualities or not. If the machines are not of the right sort they must be made so, but out the foreigner must go. And this in the land where International Exhibitions are a mania; what does it all mean?

Lightning Arresters.—The writer of the article to which Mr. Varley took exception sends us the following:—The footnote you kindly appended to Mr. Varley's letter of the 10th inst. renders any reply from me scarcely necessary. I should like, however, to point out that I did not refer to the vacuum protector of Sir Charles Bright at all. I mentioned a protector "which is an ingenious combination of points and fine wire remaining in working order even after a succession of discharges have passed," and I now enclose a sketch of this instrument. The object of my article was to mention names of inventors who first introduced any novel feature, and I think Mr. C. F. Varley's vacuum protector was second to both Faraday's and Bianchi's.

Mr. Gladstone's Visit to East Anglia.—The Agricultural Hall, Ipswich, in which the meeting was held to receive Mr. Gladstone, was very brilliantly lit by electricity, every point being brought well within view, whilst the coolness of the atmosphere, except in the very topmost positions in the building, was the subject of general congratulation. Messrs. Laurence, Paris and Scott, Limited, of the Gothic Works, King Street, Norwich, carried out the lighting, under the superintendence of their engineer, Mr. W. B. Sisling.

The Battle of the Brakes.—The *Financial Times* of Thursday, the 15th inst., contained a long article in which it was conclusively proved to the writer's satisfaction, if to that of nobody else, that if railway companies confine themselves to one brake it will be the Vacuum and not the Westinghouse. It is said that statistics show the former to be not only more largely used but also more reliable, but probably figures could also be quoted, say, from the *Financial News*, to prove the superiority of Westinghouse; in any case such articles as that to which we refer are not likely to settle the battle of the brakes, but at the same time we agree that it is certainly most unfair to bias the public mind against the Vacuum on the pretext that the ill-fated train, which was wrecked at Carlisle, was an example of its real merit.

Electric Traction in America.—In addition to giving figures concerning electric lighting in the intended census to which we recently referred, it has been decided to retain a section relating to electric traction. The plan of investigation which has been adopted is designed to make a comparison between the different motive powers employed to show the relative value of each. Electricians will hail this with great satisfaction, as it will place upon a sound basis the work done in this now rapidly developing branch of the industry.

Welding of Shells.—A new electrical industry has been established in West Lynn, Mass, for the manufacture of welded shells. The American Government, it is said, has given an order for 100,000 Hotchkiss gun and Shrapnel shells as soon as facilities for their manufacture, under the patent of Lieutenant Wood, U.S.N., are ready. By the new process the shells, instead of being made of cast iron and boxed as formerly, are made by welding the chilled point and butt to a section of soft iron pipe, and, in the case of Shrapnel shells, the trouble of graduating the thickness with calipers after boring and adjusting the delicately-poised diaphragm between the powder and the bullets, is greatly diminished.

Paddington Lighting.—The following resolution has been passed at a recent meeting:—"That the vestry's solicitor be instructed to withdraw the opposition to the application of the Metropolitan Electric Supply Company for a provisional order." As no instructions were given as to informing the Board of Trade it is not at all sure that the resolution as it stands is not a barren one. At all events there is to be a properly constituted meeting on the 29th, when it is to be hoped the matter will be disposed of.

The Wirt Lightning Arrester.—Says the *Electrical World:* Mr. Wirt's very ingenious lightning arrester consists merely of a pile of rather thick metallic plates connected alternately to line and earth, and separated by a film of some non-conductor. This film is readily punctured by lightning, while the cooling effect of the mass of metal prevents the formation of an arc. Therefore, the lightning will pass harmlessly to the ground, but the discharge will then cease, and the dynamo will not be short-circuited. The contrivance is a genuine sieve that lets through lightning, but holds back discharges of the tensions in regular use. Mr. Wirt does not claim more than is reasonable for his arrester, which seems to be a very simple and effective one, well adapted for general purposes. Of course it is immensely difficult absolutely to protect a dynamo from lightning, since in the case of shunt machines, at least, a very small discharge is sufficient to break through the armature insulation, producing a destructive short circuit. In spite of this difficulty, a good lightning arrester on the lines and in the station can often prevent a great deal of damage to lamps and dynamos.

The Halifax and Bermudas Cable.—On Wednesday afternoon the *Westmeath* proceeded down the river to Greenhithe, and, at the invitation of the chairman and directors of the Halifax and Bermudas Cable Company, a party of gentlemen were conveyed by special steamer from Westminster to Greenhithe to inspect the vessel with the cable on board. Among the company were Sir Alexander Armstrong, K.C.B., chairman of the company; Mr. L. H. Isaacs, M.P., deputy chairman; Mr. Rochs, manager; Mr. James Hay, secretary; Mr. Sydney Gedge, M.P., chairman of W. T. Henley's Telegraph Works Company; Mr. Graves, C.E., of the Post Office; Mr. Latimer Clark and some others, directors and shareholders in the company. On arriving at their destination, the visitors were conducted over the *Westmeath* by Captain Stiffe, the engineer in charge of the laying of the cable, who explained the method of paying out cable, of taking soundings, and other matters of interest. The length of cable on board is 874 knots of which 152 knots consist of intermediate and shore end types. After the inspection the party returned to Greenwich, and dined together at the Ship Hotel, the chairman of the company, Sir Alexander Armstrong, presiding. During the evening the chairman referred to the benefits certain to result from the successful laying of this cable, especially to Bermuda, which in the matter of communication with the mainland is at the present time very badly off indeed. Mr. Sydney Gedge also alluded to the same subject, and hinted that the cable now being inaugurated would probably only form a link in a comprehensive chain, which, when completed, would become a powerful competitive system. The Halifax and Bermudas Company have a subsidy guaranteed to them by the Government of £8,100 per annum for a period of 20 years, and while the tariff has not yet been definitely settled, it is believed that the cable rate from Halifax to Bermuda will be 3s. per word, and from London to Bermuda 4s. A few further particulars may be seen on another page.

The Goolden Cricket Club.—A cricket match was played on Saturday last at College Farm between teams of the Goolden Cricket Club, composed of the *employés* of W. T. Goolden & Co., electrical engineers. After nearly four hours' exciting play the Mechanicals were successful in inflicting on their more theoretical opponents a sound beating.

The "Daily Telegraph" on Submarine Telegraphy.—Referring to a notice concerning the proposed Halifax-Bermuda cable, which appears in the *Daily Telegraph* of the 22nd current, we are informed that "an interesting feature in connection with the laying of the cable, is that it is the first that will cross the Gulf Stream." The gentleman who gives this information seems to be unaware that all the Atlantic cables cross the Gulf Stream, to say nothing of the cables between Cuba and the United States.

Questions in the House of Commons.—On Tuesday Mr. Mather asked the Postmaster-General whether it was correct, as reported, that it had been arranged that a motion fixing an international telegraphic tariff at 12½ centimes, or rather more than a penny per word, shall be brought before the International Telegraphic Conference, which commenced its sittings last week at Paris, and that the motion will have the support of the English representatives; and, if correct, and the Conference should adopt the motion, would he endeavour to arrange with the respective Governments that the same rate of 12½ centimes should also extend to Denmark and Russia, as those countries were not members of the Telegraphic Congress, and would not be affected by its decision. Mr. Raikes: I do not feel myself at liberty to disclose the proposals which have been brought forward for discussion at the International Telegraphic Conference by the representatives of the Governments. Such a course would be unusual. Both Denmark and Russia are members of the International Telegraph Union, and are represented at the Conference; and they will therefore be affected by the decisions arrived at. I may mention that the charges for telegrams from this country to France, Belgium, Holland, and Germany were only lately reduced to a uniform rate of 2d. per word, with a minium of 10d., and I may assure the hon. member that it is certainly my desire that the representatives of this country should endeavour to bring about such further reductions in other directions as, having regard to the interests of all the parties concerned, seem to be called for. Mr. Bradlaugh asked, on the same day, the Postmaster-General whether the police had recently received instructions from the Post Office authorities to make inquiries and report as to meetings of Post Office *employés* about to be held; whether such instruction had been issued to the police generally, or in what districts; and whether he would state to the House why the police had in this respect in aan case been substituted for, or added to, the local postmaster. Mr. Raikes: No, sir. No such instructions have been given either generally or in particular localities. Mr. Bradlaugh: Then if inquiries have been made in the county of Buckingham by the police, they have been made without the instructions of the right hon. gentleman? Mr. Raikes: Certainly, sir.

The Strike at Messrs. Latimer Clark, Muirhead and Company's Works.—There seems little prospect of the difficulty which has arisen being speedily settled. The societies have decided to support the men, and are allowing them relief. As mentioned last week, the dispute has arisen between the men and the manager of the works. The complaints alleged against him are stated, in a circular issued by the Strike Committee, to be that old hands who had previously given satisfaction were dismissed, foremen have been dismissed, and, altogether, the manager's conduct became so intolerable that the whole of the staff decided to come out. On the other hand, we are informed that foremen were dismissed on account of their irregular conduct, and the men, considering themselves wronged, retaliated. We were shown the time kept by the offending foremen during the past few weeks, and it certainly reflects little credit upon any workman. If, then, the men can advance no further argument against this, we are afraid their cause is not one of any stability.

Price of Rubber in New York.—An exchange says another advance of 5 cents per pound in the price of rubber is reported from New York. If the price still continues to advance, as it undoubtedly will owing to the small available stock, we may expect an increase in the price of rubber-covered wire. Decreased production and increased demand for use in a great variety of manufactured articles have caused the advance in prices. The total available stock of all kinds of rubber in the world is said to be 3,010 tons, against 7,708 tons at the same time last year.

Communication with our Australian Colonies.—In spite of all that has been said and done to avoid it, we are not without an occasional reminder that the present means of telegraph communication between England and her colonies in the far east, and in Australia, is unreliable. On the 13th of this month it was announced that the Madras-Penang cable and the Penang-Rangoon cable were both interrupted, and that messages for Penang, China, Australia, and New Zealand could therefore only go direct by the Great Northern Company's route. That is to say, telegrams sent from England for these places could only reach their destination by passing over land lines which, after traversing portions of the European Continent, run for some 4,000 miles further through Russian territory, and crossing Siberia, terminate at Vladivostock, the naval stronghold of Russia in the eastern seas, a condition of affairs to which a route such as this between England and her colonies is the only alternative, cannot be regarded as satisfactory. That the service across these land lines may be well carried out is not in question; but the lesson taught us, is the general insecurity, even in times of peace, of the routes at present existing. That we are justified in taking this view will be apparent to our readers, when we quote the words addressed to a meeting of the shareholders of the Eastern Extension and Australasian Telegraph Company, about 18 months ago, by their chairman. Sir John Pender said, referring to the Madras-Penang cable (which at that time also was interrupted): "This is a most unfortunate part of our system, because our cable lies on very bad ground near the Nicobar Islands, where nearly all the interruptions to this cable have occurred." At the same meeting the chairman also refers to the total interruption of communication with Australia, and also to the simultaneous breakdown of the two cables to India. On the 14th instant, the repair of the Penang-Rangoon cable was announced, but this did not greatly improve the position; as messages had still to pass over about 1,500 miles of land line, running through a wild country, and it was not until the 21st that the Madras-Penang cable was repaired. We learn that a conference of the Postmasters-General of all the Australasian colonies is now being held at Adelaide, to consider, among other things, the question of cable rates, and doubtless if asked to give a guarantee of traffic as an off-set against a reduction of rates, it will become their duty to seriously consider how such interruptions as those above referred to will affect their guarantee. To us, however, the solution of the whole question is to be found neither in reduction of rates nor in the laying of additional cables, through seas which previous failures have proved to be unsuitable; but on the choice of an entirely new route, such as that across the Pacific to Canada, the advantages of which have been frequently pointed out, and which would prove a genuine alternative to the present intermittent cable service.

Underground Wires.—In the report of the Highways Committee of the London County Council on Tuesday, there were applications for the laying of mains in no less than 152 streets, all west of the Law Courts. Many of these are given in another column.

Harbour Lighting.—Consul Ward, of Bordeaux, in recording the fact that the entrance to the wet docks at that port is now lighted at night time by electricity, states that it is to be wished that this kind of light could be also installed in all other parts of the harbour, where shipping business has frequently to be carried on after dark.

A Large Order.—The Minneapolis electric road have placed with Messrs. Roebling and Son, America, an order for about 100 miles of lead encased cable and 100 miles of overhead conductor, as well as a large amount of bare copper wire, &c. The order, which is said to be the largest of the kind ever given, will be completed by July 1st this year.

Inventors and Invention.—The letter which we publish from Messrs. Waller and Manville throws a curious light upon the notions which are possessed respecting patent rights. These gentlemen evidently imagine that the person who develops an invention is of far more importance than he who evolves from his brain an idea which may be of universal utility; we, on the other hand, consider that the man who first thought of the idea should be called the true inventor, and the fruit of his genius should be well protected from mere adaptation, or so-called mechanical improvements, which he could employ any engineer to design at a fixed salary. In patent law although the methods of accomplishing a certain object appear to be substantially different, yet they may be merely mechanical equivalents one of the other. It should be remembered that some of our greatest inventors have had no knowledge of mechanics; and we can now call to mind a fast speed telegraphic instrument which, if the theory of Messrs. Waller and Manville were accepted, would no longer be called by the name of the great natural philosopher who first conceived theoretically the manner in which automatic fast speed telegraphy could be made possible. All the marvellous mechanical details of the apparatus were worked out by a gentleman equally great in his way as his more theoretically learned friend, yet nobody ever thinks of denying to the latter the splendid achievements which his genius alone rendered possible. We believe that our readers generally will agree with our remarks, for there is a tendency nowadays to take advantage of every patent which appears and improve upon it, quite ignoring the fact that the original inventor himself, in due course, would probably make the same elaborations of his embryo idea if left to his own devices. Great merit, indeed, is due to those who bring to a useful end an undeveloped or abandoned invention, but all the same they do not originate the fundamental principle which underlies the whole thing.

The Lane-Fox and other Patents.—We are not at all surprised to see that our contemporaries are pretty much agreed upon the course of action which Mr. Lane-Fox, presumably through his advisers, has thought fit to pursue. When the question of using transformers in parallel or series was raised, we said that it was difficult to conceive that anybody in his senses would hold that there existed in patent law a claim to their employment one way or the other. In days gone by, if an experimenter did not get the result anticipated with his electrical apparatus in series, he naturally tried the effect of connecting them up in parallel, and we imagine that everybody is free to do this to-day. However, it appears that communications of a nature calculated to cause alarm have already been received by some electrical firms, who, we trust, will have sufficient good sense to resist, after a lapse of so many years, any efforts, which are not strictly justifiable, to retard their enterprise. If the claim for "distribution in parallel arc in conjunction with secondary batteries as reservoirs of electricity" is generally admitted, then we may expect a similar incident to occur with an amended specification for transformers, which the brothers Hopkinson are trying to get through. Naturally this can only occur if they are successful in overcoming the opposition which we believe has been brought to bear against the granting of their amendments. Furthermore, there is likely to be squabbling over the Edison "feeder" patents, so that all things considered, the electrical trades will soon have their hands so full of law, that business must go to the wall.

Employment for the Blind.—Since engaging two blind persons, male and female, as operators, the director of the Philadelphia telephone station has received over 200 applications from persons similarly afflicted. The extraordinary hearing powers possessed by the blind, and their comparative freedom from distractions caused by outside influences, are found to be of advantage in this kind of work.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Latimer, Clark, Muirhead and Company, Limited.—The annual return of this company, made up to the 1st March, was filed on the 24th March. The nominal capital is £100,000 in £10 shares, 4,709 shares have been taken up, and the full amount is considered as paid up thereon.

Davis and Timmins, Limited.—The annual return of this company, made up to the 3rd October, 1889, was filed on the 2nd December, 1889. The nominal capital is £20,000 in £10 shares, 1,253 shares have been taken up, 300 of these are considered as fully paid up, 200 being allotted to Mr. Davis, and 100 to Beyne Brothers, pursuant to agreements upon the remaining 953 shares; the full amount has been called and paid, the calls paid amounting to £9,530.

Laurence, Paris and Scott, Limited (electrical engineers).—The annual return of this company is made up to the 3rd January. The nominal capital is £30,000 in £10 shares, 1,205 shares are taken up, and the full amount has been called and paid thereupon, the paid up capital thus being £12,050. Registered office, The Gothic Works, King Street, Norwich.

T. Potter and Sons, Limited (electrical engineers).—The statutory return of this company, made up to the 2nd inst., was filed on the same day. The nominal capital is £7,000 in £5 shares, 527 shares are taken up, 520 being considered fully paid. Upon the remaining 7 shares the full amount has been called and paid. Registered office, 44, South Molton Street, W.

Transvaal Oil Engine Company, Limited.—The statutory return of this company is made up to the 11th March, and was filed 24th ult. The nominal capital is £25,000 in £5 shares, 2,607 shares have been taken up, 2,600 of which are considered fully paid. Upon the remaining 7 shares there has been no call, and no payment has been made in respect thereof.

NEW COMPANY REGISTERED.

Electric Clean-All Company, Limited.—Capital £2,000, in £5 shares. Objects: To take over, as a going concern, the business carried on by John Bowden, E. L. Downing, and W. Cooper Penn, the nature of which is not specified. Signatories (with 1 share each): J. Bowden, *E. L. Downing, *W. C. Penn (engineer), *S. Herne, S. Fletcher, G. Hopkins, J. S. Frazer, J. Wynn, A. S. Stephens, all of Cardiff. The signatories denoted by an asterisk are the first directors. Qualification, £50 in shares or stock. No remuneration is to be paid to the directors until the ordinary shareholders receive 6 per cent. per annum dividend, when the amount of remuneration will be determined in general meeting. Registered 16th inst. by Bell & Co., 9, Bow Churchyard. Registered office, 94, St. Mary Street, Cardiff.

Devon and Cornwall Electricity Supply Company, Limited.—An issue is announced of £75,000 in 14,900 ordinary shares of £5 each, and 100 founders' shares of £5 each, being a portion of a total share capital of £100,000. The company has been formed to establish in the leading towns of Devon and Cornwall, central stations, at which electricity can be generated on a large and economical scale. The first centre of the company's operations will be Plymouth.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ended May 16th, amounted to £3,765.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending May 16th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,896.

West India and Panama Telegraph Company, Limited. The estimated traffic receipts for the half month ended the 15th May, are £3,200, as compared with £3,151 in the corresponding period of 1889.

SHARE LIST OF ELECTRICAL COMPANIES

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (May 15).	Closing Quotation. (May 22.)	Business done during week ending May 22, 1890.	
					Highest.	Lowest.
£						
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	98 —101	98 —101		
1,549,160	Anglo-American Telegraph, Limited	Stock	50 — 51	50 — 51	50½	...
2,725,420	Do. do. 6 p. c. Preferred	Stock	85 — 86	86 — 87	86⅜	85½
2,725,420	Do. do. Deferred	Stock	15¼— 15⅜	15¾— 16⅛	16	15 1/16
130,000	Brazilian Submarine Telegraph, Limited	10	12 — 12¼	11⅞— 12⅛	12⅜	11⅞
99,000	Do. do. 5 p. c. Bonds...	100	101 —103	101 —103		
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	105 —108	106 —109		
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416... ...	3	2⅛— 2⅛	2⅜— 2⅝	2⅞	2⅛
63,416	Do. do. Preference, Nos. 1 to 63,416 ...	2	1⅝— 1⅞	1⅝— 2	1⅞	1⅝
224,850	Consolidated Telephone Construction and Maintenance, Ltd. ...	14/-	9/16— 11/16	9/16— 11/16	⅝	...
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5¼— 5⅜	5¼— 5⅜		
16,000	Cuba Telegraph, Limited	10	11 — 11¼	11 — 11⅛	11⅜	...
6,000	Do. do. 10 p. c. Preference	10	17½— 18½	17½— 18½		
12,931	Direct Spanish Telegraph, Limited ... (£4 only paid)	5	3¾— 4¼	3⅞— 4¼		
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10		
60,710	Direct United States Cable, Limited, 1877	20	10¼— 10⅜	10¼— 10⅜	10 5/16	10
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	13⅜— 13⅞	13½— 14	13⅞	13 1/16
70,000	Do. 6 p. c. Preference	10	14⅞— 15½	14⅞— 15½	15½	...
200,000	Do. 5 p. c. Debs. (1877 issue), repay. Aug., 1899	100	107 —110	107 —110		
1,200,000	Do. 4 p. c. Mortgage Debenture Stock	Stock	107 —110	107 —110	109¼	108
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	13⅛— 13⅜	13¼— 13⅜	13 13/16	12 15/16
320,000	Do. 6 p. c. Debentures, repay. February, 1891	100	100 —102	101 —103		
446,100	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. ...	100	103 —106	103 —106		
12,500	Do. 5 p. c. Debentures, 1890, redeem. ann. drawings ...	100	103 —106	103 —106		
367,900	Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900...	100	102 —105	102 —105	103⅛	103
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4⅜— 5⅛	4⅜— 5⅛		
46,700	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	5 — 5⅛	4⅞— 5⅛	5⅛	5⅛
19,700	Fowler-Waring Cables, Nos. 301 to 20,000 ...(£3 only paid)	5	2⅛— 2⅜	2⅛— 2⅜		
180,227	Globe Telegraph and Trust, Limited	10	8⅛— 8⅞	8⅛— 8⅞	8 13/16	8⅛
180,042	Do. do. 6 p. c. Preference	10	14⅜— 15	14⅜— 15	14⅛	14 5/16
150,000	Great Northern Tel. Company of Copenhagen	10	15½— 16	15½— 16	15⅝	15⅝
40,000	Do. do. 5 p. c. Debs. (issue of 1881) ...	100	102 —105	102 —105		
250,000	Do. do. do. (issue of 1883) ...	100	104 —107	104 —107		
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000 ...	10	12½— 13½	12½— 13½	12 13/16	12½
5,334	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11 — 12	11 — 12		
41,600	India-Rubber, Gutta-Percha and Telegraph Works, Limited ...	10	18 — 19	18½— 19⅛	19	18½
200,000	Do. do. 4½ p. c. Deb., 1896...	100	103 —105	103 —105		
17,000	Indo-European Telegraph, Limited...	25	38 — 40	38 — 40	39¼	38
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7 xd	6 — 7 xd		
100,000	Do. do. do. 6 p. c. Debentures ...	100	107 —110	107 —110		
49,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000 ...	10	5½— 5⅝	5 — 5⅛		
386,875	National Telephone, Limited, Nos. 1 to 386,875	5	5⅜— 6	5⅞— 6⅛	6 1/16	5 15/16
49,825	Do. New Nos. 386,876 to 436,700	5	5½— 5⅝xd	5⅝— 6 xd	5 11/16	5⅝
15,000	Do. 6 p. c. Cum. 1st Preference	10	12⅛— 12⅜	12⅛— 12⅜		
15,000	Do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	10 — 11	10⅛— 10⅜		
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	¼— ⅜	¼— ⅜		
9,000	Reuter's, Limited	8	7½— 8	7½— 8⅜		
209,750	South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	¼— ...	¼— ...		
20,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3¼ only paid)	5	3¼— 3⅜	3¼— 3⅜		
3,381	Submarine Cables Trust	Cert.	110 —115	110 —115	114	...
78,949	Swan United Electric Light, Limited ... (£3½ only paid)	5	4⅜— 5⅛	5 — 5⅛	5 5/16	5⅛
37,350	Telegraph Construction and Maintenance, Limited	12	44 — 46	44 — 46	46⅛	45
150,000	Do. do. do. 5 p. c. Bonds, red. 1894	100	101 — 104	101 —104		
55,000	United River Plate Telephone, Limited	5	4½— 5	4½— 5		
146,000	Do. do. 5 p. c. Debenture Stock... ...	Stock	90 — 94	90 — 94		
100,000	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...		
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	9 — 10	9 — 10	10	...
300,000	Do. do. do. 5 p. c. Debentures	100	99 —102	99 —102		
30,000	West Coast of America Telegraph, Limited	10	5⅛— 6⅛	5⅛— 6⅛	6⅛	6
150,000	Do. do. do. 8 p. c. Debs, repay. 1902 .	100	117 —122	117 —122	119	...
64,572	Western and Brazilian Telegraph, Limited	15	10 — 10½xd	9¾— 10⅛xd	10⅛	9⅞
26,986	Do. do. do. 5 p. c. Cum. Preferred	7½	6½— 7	6⅝— 7 xd	6⅞	...
26,986	Do. do. do. 5 p. c. Deferred	7½	3¾— 4⅛	3¾— 4⅛xd	3⅞	3¾
200,000	Do. do. do. 6 p. c. Debentures "A," 1910...	100	106 —109	106 —109		
250,000	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	104 —107	104 —107		
88,321	West India and Panama Telegraph, Limited	10	2⅜— 2⅝	2⅜— 2⅝	2⅝	2⅛
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11⅛— 11⅛xd	11 — 11⅛xd	11⅛	11
4,669	Do. do. do, 6 p. c. 2nd Preference ...	10	12⅛— 13⅛	12⅛— 13⅛	12	...
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	$1,000	120 —125	120 —125	123½	123
179,300	Do. do. 6 p. c. Sterling Bonds	100	99 —101	99 —101		
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£2 only paid)	5	1⅛ — 2	1⅛— 2		

* Subject to Founders Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 6½—7½.—Electric Construction Corporation (£10 paid), 9¾—10¼.—House-to-House Company (£5 paid), 5—5½.—London Electric Supply Corporation, Ordinary (£5 paid), 2⅜—2½.—Manchester Edison and Swan Company, £9, (£1 paid), 11/- —12/-.

BANK RATE OF DISCOUNT.—3 per cent. (17th April, 1890).

THE ELECTRIC LIGHT IN PARIS.

(*Continued from page* 541.)

M. LYON-ALEMAND: I believe it is absolutely impossible to pretend that we cannot, in a year from now, construct compressed air engines in France. But as I would not let it be supposed that the article which we present to you is impossible of execution, I propose to modify the reading thus: "For compressed air engines the period shall be a year, but the Administration is invited not to let any of foreign manufacture enter into the service unless it be proved that it is impossible to procure them in France." (Interruptions.) M. Ferdinand Duval: If there are none in France we shall soon see. M. Levraud: Already M. Popp, in a document which we have received, has told us that there was not a compressed air engine in France. Engineers have told me the opposite. The first compressed air tramcars were made in France; the Nogentais tramways were worked in this manner. I may add that the names of several French makers capable of making compressed air engines have been given me. M. Guichard: But for very different uses. M. Lyon-Alemand: The Technical Commission declares that the construction of compressed air engines will be very easy to realise in France. I therefore withdraw my proposition for an alteration of Article 2. The President: I put Article 2 to the vote. The article was adopted. The President: Article 3 is as follows: "Currents produced by the Thomson-Houston dynamos shall not pass through the canalisations conceded for the private service." M. Maurice Binder: It would be interesting to know the opinion of the Prefect of Police on this subject. The Secretary-General of the Prefecture of Police: The establishment to which M. Binder alludes is the "Montagnes Russes." I have been there within the last few days to carefully examine the working of the engine, and I have been able to convince myself that there was neither motor nor dynamos in the establishment. M. Lyon-Alemand: That is not long ago. The Secretary-General: A month, perhaps. I only found one small pump, used to raise the water for an artificial cascade. The only wires which distribute electrical energy are wires insulated on porcelain supports, and placed out of the reach of the public. We required that the workmen employed on these installations should have insulated gloves and India-rubber boots. We have in this way taken all the precautions which prudence demands and which circumstances permit. That said, gentlemen, am I going to pretend that all chance of danger is removed? Certainly not. M. Maurice Binder: That is not very reassuring. The Secretary-General: I must recognise that a certain amount of danger still exists, but not greater certainly than that to be feared from continuous currents of such a force. Moreover, I do not insist on this point, and I simply entrench myself behind the opinion of the technicians. I repeat, then, there is a certain danger. But, in truth, what is the natural force which, applied to industrial use, does not constitute some peril? At the inception of steam engines they presented grave dangers, and it is impossible to pretend that they do not present them to-day. That is no reason why we should give them up. The question may be summarised, then, in simple terms. Granted that, at the beginning, the electric lighting industry can only live on condition of employing economical means, we have been led to make use of engines answering that desideratum. Must we, for fear of a danger which is not greater than the dangers presented by analogous industries, arrest the upward rise of an industry of which the future cannot yet be calculated? The Technical Commission formed at the Prefecture of Police, and after it the Prefecture of Police, have not thought so. I conclude by this consideration, which I point out to M. Lyon-Alemand: if electric lighting by alternating currents presents such dangers as to lead to its being given up, I ask how is it that the Commission, which has installed electricity in the Halles and neighbourhood, chose continuous current dynamos, and not Ferranti alternating current dynamos? M. Lyon-Alemand (reporter): I am not certain that the Ferranti dynamos of the Halles will not cause us vexation. But the difference there is between these dynamos and the Thomson-Houston dynamos is that in the Ferranti dynamos the high tension currents stop at the doors of the house, thanks to a transformer. It was not, however, on my proposition that these dynamos were adopted. I wish to point out to the Secretary-General that he is giving the Thomson-Houston dynamos a fine advertisement. The Secretary-General: I have only spoken of alternating current dynamos. M. Lyon-Alemand: Many stations work properly, and do not use the Thomson-Houston dynamo. A number of theatres are lighted by dynamos of low tension. I do not hesitate to affirm that continuous currents, even of 500 volts, do not offer any danger. But it is not the same for other currents. The Secretary-General recognises the dangers presented by these currents. He says the workmen only touch the wires with India-rubber gloves, and that they wear *sabots*. I lately saw an installation of this nature, and I saw a workman, without being protected with gloves, touch one of the poles of the dynamo. It is certain he would have been struck if, unfortunately, he had produced a contact of the two poles. Some precautions should, therefore, be taken to prevent such accidents. There is another point with which we must occupy ourselves: I refer to the safety of persons who do not know that they are near any danger. Spectators in theatres and passers-by in the streets have wires by the side of them, contact with which may be fatal. The Prefecture of Police must look to it. The danger of a steam engine is seen; the danger I speak of is not seen. I am sure the Secretary-General would look twice before having a current of 1,200 volts installed at his house——. The Secretary-General: I have gas. It is just as dangerous. A tap left open by accident, and danger of explosion or asphyxiation is risked. M. Lyon-Alemand: No. Gas betrays its presence by its smell. If we were forced to take this system, I will give way in the direction of the Secretary-General. But we can do without it very well, and there are some installations which do without it perfectly, and, if I were not afraid of appearing to wish to advertise certain theatres, I would quote some which are very brilliantly lighted by other systems by small tensions. M. Sauton: Gentlemen, I ask that this question be sent to the Consultative Committee; we have not thought of that in our specification; possibly we were wrong; but we cannot now return thereon. M. Lyon-Alemand: Not at all. M. Sauton: Then I shall insist. What you wish at the bottom is to interdict high tension currents in Paris. M. Ferdinand Duval: Why to the Consultative Committee? M. Sauton: The interpretation of the terms of the specification is in question. To say that we do not want high tension currents in Paris is to go against progress. The Secretary-General: Exactly; let us return to the stage coaches! M. Sauton: We have before us companies working different systems. The Marcel Deprez Company has for its system a series of powerful works capable of supplying a radius of 600 to 700 mètres. The Place de Clichy Sector Company can feed a radius of 2,500 to 3,000 mètres. The Popp Company employs high tension currents. M. Maurice Binder: It will do like the other companies. M. Sauton: It was when you drew up the specification that you should have determined the system which you wished to see employed. M. Maurice Binder: There is no need of a specification to invite the Prefecture of Police to take measures for the public security. M. Guichard: Vehicles crush more people than are killed by electricity. M. Sauton: The Marcel Deprez Company is about to use dynamos producing a large number of volts, and I consider that at this moment we cannot enter upon a full discussion. Why is it wished to proscribe the Thomson-Houston dynamo? It is employed everywhere in America, because it offers the advantage of regulating itself in proportion as the lights are extinguished. For my part, I fear that the

voting of the Commission's conclusions created a difficult position for us, and may become even the source of a great lawsuit for the city of Paris; and I declare that I decline all responsibility in that respect. M. Lyon-Alemand: That is an error of fact. A point which is outside the discussion is now being discussed. M. Guichard: A technical question is being discussed. What is the danger of the Thomson-Houston dynamo? It is their high tension, for I suppose it is not their name which frightens us. We must, then, not say: We prohibit the Thomson-Houston dynamos. We must say: We prohibit all dynamos the current of which can kill a man by passing through his body. It is a heresy to maintain such a thesis; as well say you prohibit electricity for ever. The future is precisely in high tension dynamos. With them we can go a long way in using their wires; a city like Paris can be covered cheaply. Two years since two thick wires like cables were necessary to go from the Hôtel de Ville to the Champ de Mars. Now a telegraph wire suffices to transmit electrical energy from Creil to the Northern Station. We do not, then, proscribe the Thomson-Houston dynamos or proscribe all the high tension dynamos. As to the dangers, the vehicles offer more than electricity. We could go far with such arguments, and we should rapidly return to the Flood. The truth is, when we have to do with great forces we must defy them. Certain conquests of men are dangerous, but they are useful, and, to a certain extent, necessary. M. Maurice Binder: It is well to remark that that the current which comes from Creil is transformed on arrival at Paris. M. Lyon-Alemand: Gentlemen, you are now discussing a question which is outside the present debate. M. Binder addressed a question to the Prefect of Police as to the working of the Thomson-Houston dynamos; that gentleman answered, and there is an end of it. As for us, we have never thought of interdicting these dynamos; we have only stated our responsibility. M. Maurice Binder: We leave this responsibility to the Prefect of Police. The Secretary-General: Pardon me, to the Technical Committee. M. Lyon-Alemand: Our duty here is to cause the specification to be respected, and that specification requires that all the apparatus should be made in France. Now the Thomson-Houston dynamo is of foreign make, therefore —— M. Emile Richard: And the Ferranti dynamos? M. Lyon-Alemand: The companies which use the Thomson-Houston dynamos tell us: We use this system for the lighting of the boulevards, but we do not have recourse to it for private lighting. I ask the Administration, since they say these currents must not be used for private lighting, to see they are not used for that lighting. The Director of Works: There is one thing I do not understand, and that is when a dynamo manufactured abroad is recognised as good, and there exists nothing similar in France, we are forbidden to use it, to the great profit of the lighting. When we are asked a question clearly and without subterfuge, the Technical Committee will answer the question yes or no. It will answer yes if the dynamo cannot be replaced by a French one. In the contrary case it will answer no. Remember, gentlemen, what happened after your vote on the Ferranti dynamos. A factory for making them was at once established in France. It would be the same for the Thomson-Houston dynamos, if it were wished; they would very quickly be manufactured in France. We have the same right to protect our industry against foreigners as America protects hers against us. M. Sauton: I agree with you.

(*To be concluded.*)

Glasgow Electricity Bill.—We understand that all opposition to the Glasgow Corporation Bill, which asks Parliament to "authorise the Corporation of Glasgow to make and maintain river walls or embankments on the river Clyde, to confer power on the Corporation with respect to the supply of electricity, the regulation of their markets, and for other purposes," has been withdrawn.

THE INTERNATIONAL CABLE COMPANY.

THE daily journals of May 19th contained reports of the further hearing of the petition, brought by Mr. Bolton, for the compulsory winding up of this association, on the ground that the company was no longer in a position to fulfil its obligations. For not only had the concession granted by the Portuguese Government for a cable from Portugal to the Azores lapsed, and the deposit of £10,000 become forfeited, but the number of shares applied for in the formation of the company was too small to enable it to carry out the scheme, which embraced not only the cable between Portugal and the Azores, but also cables between the Azores, the West Indies, United States of America, Canada, and Great Britain, or any part of Europe.

The company was formed in 1885 with a nominal capital of £1,000,000, in 100,000 shares of £10 each, and in the same year it became proprietor of a concession granted to the firm of Bensaude and Company by the Portuguese Government, for the laying and working of a cable between Portugal and the Azores, with an exclusive privilege of 20 years, but unless the cable were completed within one year the concession would lapse and the deposit money forfeited.

In 1886 the company issued a prospectus, offering to the public a first issue of £600,000, in 60,000 shares of £10 each. As we before stated, the number of shares applied for was too small, the return made up to May, 1889, showing nominal capital, £1,000,000; shares taken up, 25,194. The company was consequently unable to lay the Bermuda-Halifax cable, which formed a portion of the scheme; and although the Portuguese concession had been extended up to June, 1889, for the laying of the Portugal-Azores cable, only an insignificant portion—a small piece of shore end—of that section had actually been laid.

On behalf of the company it was claimed that the Portuguese concession could be renewed; that a portion of shore end had been laid which would ultimately become of value; that the company's business was not confined to the laying of the Portugal-Azores cable; that the company had promoted the Halifax-Bermuda Cable Company with a share capital of £24,965, of which the International Cable Company had taken three-fifths; that if wound up the company would lose the deposit with the Portuguese Government of £10,000; and that there were reasonable prospects of the company's obtaining sufficient capital for carrying out its scheme.

The Court decided that, as the primary object of the company was to lay the Portugal-Azores cable, and since there was a probability of the concession being renewed, the case should stand over till the third petition day in July, the company undertaking not to enforce payment of arrears of instalments due on the plaintiffs' shares.

It would appear that the position of the International Cable Company is none too hopeful, and it would seem that, at all events for the present, those companies which for many years have had the monopoly of telegraphic communications between the northern portions of South America, the West India Islands, and the coasts of the United States, have escaped the possibility of a coalition which, if undertaken with determination, might have proved disastrous to them.

We have had occasion to peruse the columns of some Lisbon journals, and as an evidence of Portuguese opinion upon the concession so frequently renewed to the International Cable Company, we cannot do better than quote the views expressed by one of the leading Portuguese papers.

The journal we refer to makes the following complaints: (1) That notwithstanding the evidence as to the true condition of affairs, it has only been due to the repeated insistance of the public that the late Minister of Public Works drew up the necessary decree rendering the concession obtained by the International Cable Company null and void, with forfeiture of the £10,000 deposit money; (2) that this decree did not

receive the Royal signature; (3) that for 20 years the inhabitants of the Azores have vainly urged their claims for telegraphic communication, and that now they see their just demands ignored, and the benefits they are entitled to, conferred upon remote and unimportant districts in West Africa; (4) that no valid reason can be brought forward for a continuance of the farce of repeated renewals of the concession and prorogations of time in face of the official reports already in the hands of the Government.

The question is thus discussed whether the State should lay the cable on its own account, or give a concession with a guarantee of interest; for, our authority goes on to say, it has been sufficiently proved that without a Government subsidy the Portugal-Azores cable will certainly not be laid.

The article concludes with a vigorous appeal to the Government to put an end to the present anomalous state of affairs with regard to this concession.

ON AN ACCIDENTAL ILLUSTRATION OF THE EFFECTIVE OHMIC RESISTANCE TO A TRANSIENT ELECTRIC CURRENT THROUGH AN IRON BAR.*

By Sir WILLIAM THOMSON.

THE wonderful accidental experiment of Lord Armstrong may briefly be described as follows:—A bar of steel which Lord Armstrong was holding in his hand, was allowed accidentally to come in contact with the two poles of a dynamo giving 85 ampères and 103 volts. A painful sensation of burning was instantly felt and the bar was dropped. Severe blisters occurred where the hand or fingers touched the bar, which was found immediately afterward to be quite cold, or not perceptibly hot. This marvellous incident proved: (1) the outer surface of the steel to have been intensely heated; (2) that not enough heat was generated to sensibly warm the whole bar. The explanation, of course, is to be found in the known laws of diffusion of electric currents through non-magnetic conductors, considered in connection with the effect of magnetic susceptibility, of unknown amount and law, in conductors of steel and iron.

The requisites for working out fully the theory of transient or periodic currents in conductors of any form are included in Maxwell's fundamental questions, and are given explicitly for straight cylindric conductors of non-magnetic material in sections 685—689 of his work. Lord Rayleigh, in his paper "On the Self-Induction and Resistance of Straight Conductors" (*Phil. Mag.*, May, 1886), gives the formula for transient or periodic currents in straight cylindric rods of iron, on the supposition of constant magnetic susceptibility. The details of this highly interesting and important branch of the subject have also been investigated by Heaviside in a very comprehensive manner. The tendency of periodically alternating currents to be condensed on the outer part of a cylindric conductor, while the current may be exceedingly feeble or quite insensible in the central parts, was discussed and explained by Lord Rayleigh in page 388 of his article already referred to, and its aggravation in an iron conductor specially pointed out. The same considerations show that a transient current resulting from the application, for a very short time, of the electromotive force of a voltaic battery, or of electro-magnetic induction acting not directly on the cylindric conductor considered, but on a conductor such as the inductor of a dynamo of any kind, momentarily in circuit with it, is only skin deep if the duration of the electromotive force be but short enough; and that the depth to which the current penetrates in a given very short time is much smaller for iron than for copper.

To find something toward a mathematical solution for the increasing current at any instant during the electric contact of Lord Armstrong's experiment, it is convenient first to consider the problem of finding the subsidence of current initially given in a circuit of two long parallel bars connected by end bridges, or in a circuit of two long bars insulated, within a conducting sheath, except at its ends, which are in metallic connection with the sheath. If afterwards we suppose the conductors and one end bridge to be given with no current, and that a voltaic battery giving constant potential be suddenly applied instead of the other end bridge, the rise of current through the parallel conductors from its initial zero to its ultimate steady amount will follow *nearly* the same law as the fall from the initial steady current to the final zero in our former simple case. The law will, indeed, be *exactly* the same if the quantity of positive electricity on one conductor and of negative electricity on the other, requisite to charge them as a condenser in virtue of the gradient of potential, is nothing in comparison with the quantity flowing through the circuit. The quantities of electricity set in motion in consequence of electro-static and electro-magnetic induction vary considerably in relative importance, according to the problem considered. For many telegraphic and telephonic problems the static charges are by no means negligible, and in the ocean cable problem they are of paramount importance, the electro-magnetic induction with which we are now occupied being in this case quite negligible. In shorter cables, and with high-speed action, both the electro-static and the electro-magnetic induction must be taken into account, and both have been practically considered by Heaviside in the mathematical theory of the telephone. In the vast majority of laboratory arrangements, the currents required for the static charges are quite negligible, as is also the case with Lord Armstrong's experiment, so that the problem is reduced to considering the natural subsidence of a current under the action of no electromotive forces save those induced by its own rate of change.

In all cases of electric currents given in parallel straight lines, and left to subside, naturally the thermal analogy is most convenient. For electric conductivity, we have thermal capacity divided by 4π; for magnetic permeability, the reciprocal of thermal conductivity; and for current density, temperature multiplied by thermal capacity. Thus, if two infinitely long straight parallel conducting bars, separated by insulating material, be given with equal currents in opposite directions through them, and left to themselves, we have precisely the same mathematical problem to solve as if in every line of the thermal analogue we had initial temperature multiplied by thermal capacity given equal to the current density in the corresponding line of the electro-magnetic problem, and the system left to itself, with the positive and negative temperatures in the two bars subsiding toward zero. The quantity of heat generated per unit of area per unit of time, at any point of either interface in the thermal analogue, is equal to the rate of variation per unit of length along the electric conductor of the electrostatic force in the insulator in contact with it in the electric analogue. The fall of temperature in the latter case will correspond in some respects with the diminution of the current in the former, and the rise of current in different portions of the conductor when suddenly subjected to an applied electromotive force will correspond with the rise of temperature in different parts caused by the sudden exposure of the surface of the body to a high temperature.

The case of a bar of circular section surrounded coaxially by a hollow circular cylinder is next to be considered. To further simplify matters it is further supposed that the conductivity of the sheath is very great. The problem then becomes mathematically the same as that of a heated cylinder allowed to cool, which was presented and fully solved by Fourier in the sixth chapter of his "Théorie Analytique de la Chaleur." The numerical values to be taken in representation of the various physical properties of the material are then considered. Thus the permeability of the steel is taken as 300 by way of example and illustration; but as the permeability varies enormously with the amount of the magnetising force, and in a manner desperately complicated by hysteresis, no accurate mathematical investigation is practical with only our present knowledge to guide us. The conclusion arrived at in this particular case is that during the first $\frac{1}{1000}$th of a second, the diffusion is unaffected by the curvature of the conductor, and follows sensibly the law of plane laminar diffusion. The supposition of the circular cylindric sheath of negligible resistance, adopted for the sake of simplicity, may accordingly be departed from, since the solution will be nearly the same for the case of two parallel rods, provided the distance between them is a considerable multiple of the diameter of either. Although the circumstances in Lord Armstrong's experiment are of such extreme complexity that it is of no use to attempt to work out a complete mathematical theory, it seems very probable that the solution thus indicated fairly illustrates the circumstances of the current which actually flowed through the steel bar. At all events, ample explanation of the intensity and suddenness of the effect perceived by Lord Armstrong is obtained by working out the result numerically of what would take place if a difference of potential of 100 volts were suddenly instituted, and forcibly maintained constant during one, two, or three ten-thousandths of a second between the ends of the bar.

It must not, however, be supposed that the difference of potential between the ends of the bar was in reality constant at 100 volts, even for so short a time as this. What was really constant was the strength of current through the electrodes leading from the complex dynamo circuit of the armature, and shunt and series coils of the electromagnet, to the external lighting circuit, and to the temporary circuit through the steel bar. The immense quasi-inertia of each partial circuit within the dynamo, prevented any great augmentation of the the outgoing current during the few hundredths of a second during which the short circuit occurred, and, with probably no practical error, it may be supposed that the outgoing current was constant at 85 ampères, the electric lighting circuit losing as much current as that which was passing through the bar. Since the quasi-inertia of the lighting circuit was very small, it seems quite probable that the whole of this current for the first few thousandths of a second passed through the outer skin of the steel bar. There is thus no difficulty in understanding the origin of the sudden high temperature of the surface which Lord Armstrong perceived, and yet that the whole amount of heat generated was insufficient to heat the bar to any sensible degree. If the dynamo had been doing no work externally at the time of the accident, the time required to get up a strong enough current out of the dynamo to produce much heating effect would have been very much longer than it was.

* Abstract of paper read before the Royal Society of Edinburgh, March 17th, 1890.

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

(*Continued from page 560.*)

I HAVE now to report that Dr. Alex. Muirhead has kindly made me an actual and highly-finished instrument on this plan; designing it himself. This instrument I have here (fig. 10), and I have also received from him to-day this round and more compact, and,

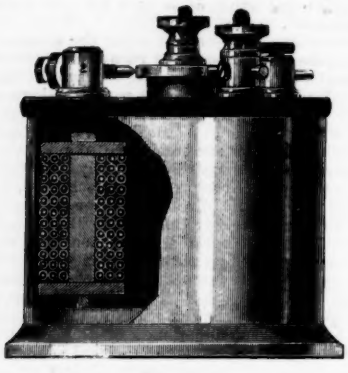


FIG. 10.

I suppose, cheaper form of the same instrument (fig. 11), with one-half the coils omitted, according to a plan of mine which, though not in all respects so theoretically satisfactory, may answer well enough for many purposes—as I shall mention further on.

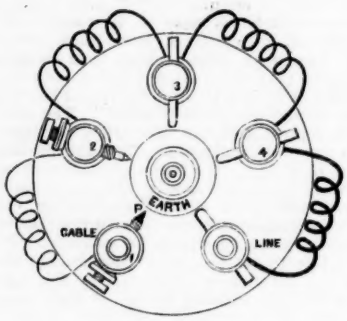


FIG. 11.

I now insert the first-mentioned protector in the path from Leyden jars to galvanometer, and I show that with all sized flashes, from the smallest to the biggest here practicable, the galvanometer is protected; its needle does not move, neither does its safety valve sparkle. Examining it still more strictly and rigorously, I find that the insulation protection is indeed quite perfect, but a faint trace of a wave does pass round the galvanometer wire, and affects the needle slightly when in a sensitive condition. To see this clearly, one must allow the needle to recover from the disturbance due to the charging current before permitting the discharge. The galvanometer shows easily the charging current from a common frictional plate machine; in fact, the spot of light moves several inches with such a current. Connecting it up through the protector, with a small single pair of plates inductive machine charging the jars and giving pretty long sparks, the usual occurrences observed are as follows: between each spark, while the jars are charging, the spot of light deflects considerably, gradually less as the jars get fuller, until they discharge; when, instead of a kick back, as one might expect, there is rather a leap forward, by reason of the suddenly restored strength of the now almost unopposed charging current.

Whenever we thus want to see the charging current, we must, of course, make fair metallic contact with the outsides of the jars, so as to close the circuit through the galvanometer; but, in order to further test the instrument, I make a break at one or both of its terminals, and allow flashes to strike either A or B, or both. It is not really a more severe test than the other—not quite so severe, in fact; but it looks worse, perhaps, and, at any rate, it is the simplest plan of keeping the charging current out of the galvanometer, and so securing that the needle shall be ready to indicate the slightest effect which the unfiltered-off portion of the discharge is able to produce. But there is practically no effect to be seen.

You observe that my instrument is symmetrical, *i.e.*, that there are just the same coils in its earth-connected as in its insulated portion. It may easily be supposed that this doubling of the parts is unnecessary, or even deleterious. It may be plausibly argued that coils interposed in the earth connection are bad as well as useless, and that both the terminals on that side, B and D, should be agglomerated together; that, in fact, a preferable pattern would be that shown in fig. 11, where there is only one earth terminal towards which all the others point. I think, indeed, that there are many cases where this will serve sufficiently well, but I do not regard it as so theoretically sound as the other, for this reason. It proceeds on the assumption that every disturbance arrives from above, and is anxious to make its way to the earth. But we have no guarantee that such shall be always the case: disturbances are as likely to reach the apparatus from below, surging up from earth to line, and in that case the coils are wanted in the earthed half of the instrument. I return to this question later.

When I speak of a disturbance travelling from earth to sky, instead of from sky to earth, I do not mean that in one case the sky is negative and in the other positive. Questions about sign of charge have nothing to do with it. There is some amount of unnecessary haze abroad on this matter. Think of a sudden electrical disturbance imparted to a thin isolated copper wire; it starts at some point and flashes along the wire with precisely the speed of light, and the electric wave or pulse reaches the different portions of the wire in successive epochs of time.

Instead of a single wire, think of what must always exist, viz., a closed circuit; two pulses or waves originating at some point of this circuit flash round in both ways, at a pace usually rather less but never more than the speed of light, and meet at the antipodes of the starting point. If the circuit is unclosed, each pulse will get reflected and return, surging to and fro perhaps several times, and in such cases any point of the wire is reached by pulses travelling first one way and then the other—a phenomenon very characteristic of disruptive disturbances; but the first pulse is likely to be the strongest. It must be clear, I think, that for such alternating currents, as well as for rushes of uncertain direction, a symmetrical protector is best.

To illustrate these things, make a few more experiments with Saunders's protector, which I choose as one of the best; any other will do.

Experiment No. 8.

Connect a Saunders protector to earth and to any line wire in the proper way, and attach a single wire to the "protected" terminal; like the wire, C, G, in fig. 3. Now send a discharge between line and earth either way, and the "protected" wire will be found ready to give off sparks at every flash. It will spark to anything: to the earth, to an insulated body, even to its own earth screw, B or D. Connect it to a galvanometer, or, better, a coil of wire one has no compunction in spoiling; then if the far end of the coil be attached to anything, either to the earth or to another line, or to an insulated body—even an insulated body of small size—sparks between the turns of wire will demonstrate the fact that the insulation is being broken down by the lateral waves rushing along the nominally "protected" wire, and being either reflected or absorbed according as it is connected to an insulated body or to the earth. The connection which permits least disturbance is to the screw B or D. But there must be no chance of the galvanometer being either purposely or accidentally connected to earth in some other way also, else even this partial protection has its virtue removed.

Experiment No. 9.

The "earth" in the previous experiment being the gas pipes; instead of striking the instrument by a flash direct, let a flash be imparted to the gas main at some other point—say in another room—to typify the possibility of a lightning flash striking the earth in the neighbourhood of a telegraph station. Immediately some of the charge splashes up from the earth, and the protected wire again emits a spark; or, if it be connected to anything by a scrap of fine wire, that wire may be deflagrated. Thus we see that earth connection is not so utterly safe as might be supposed; secondary surgings may rise up out of the ground and do damage to whatever is connected to it. I believe there are more instances of such occurrences than are usually recognised. But I prefer to leave the enumeration and discrimination of instances to persons of experience.

Experiment No. 10.

But now insert in the so-called protected wire an arrangement of air gaps and self induction coils, after the fashion which constitutes my system of protection (fig. 12). Then, inserting a fine wire, or a coil, or a galvanometer, or any other detector, in the interval, and connecting the far end of the wire to anything as before, it will be found that although every trace of signalling current is able to affect the galvanometer, no appreciable trace of a violent disturbance is felt there; it is now securely protected whichever way the disturbance comes.

The electro-magnetic inertia possessed by the coils protects it from sudden currents in the same manner as the inertia of a penny protects it from disturbance when it is balanced on a finger with card under it, and the card smartly fillipped away. It is not, however, to be supposed that inertia alone, without successive air gaps can exert this protective influence. The coil of a galvanometer has plenty of the required impedance, far more than the thick wire coils on my instrument, but the only effect of that is to shunt violent disturbances through the insulation—by no means a satisfactory property. The *combination* of air gaps or escape valves along with obstructive inertia is essential to the device. Let me here interpolate the remark that the self-induction of my coils is quite small; a very small amount of

wire thus distributed suffices. Three or four yards of No. 16 wire are all I need use. I am well aware of the objection to introducing great self-induction in circuits where rapidity of signalling is desired.

With respect to the use of the one-sided pattern (fig. 11), its effect will be represented in fig. 10 if the right-hand set of coils are are short-circuited out by a thick-wire. In that case the galvanometer, though it is protected from disturbances arriving from the left, is exposed to those coming from the right.

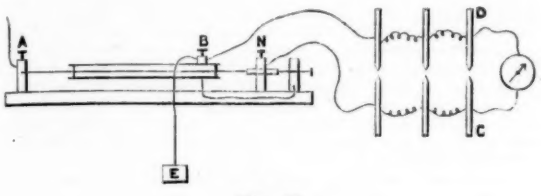


FIG. 12.

This dichotomised pattern is therefore only permissible when there is a fair presumption, or complete certainty, against disturbances arriving this way. Cases of this sort will be mentioned in connection with the protection of cables.

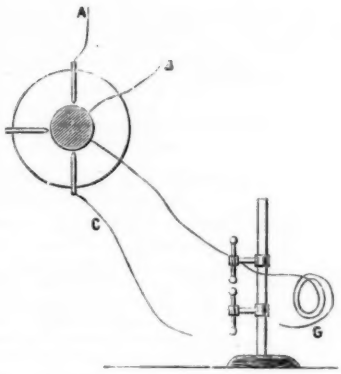


FIG. 12A.

The patterns so far drawn correspond rather to the sort suitable for a terminal station; but for an intermediate station where an "up" and "down" line wire meet, but where there is no necessary "earth," except an earth adapted to filter off lightning disturbances from the wire instead of passing them from station to station, the following pattern is suitable (fig. 13). It explains itself; it is virtually the round pattern doubled.

SUBMARINE CABLES.

All that has been said applies by implication to the protection of cables, as much as to any other sort of covered wire out of which it is desired to keep violent rushes of potential, but about cables there are a few special things to be said which we will proceed to say now. Not only is a cable a tremendously valuable piece of property, in which a slight fault costs a large sum to repair, and hence the utmost precaution ought to be taken in their case (even the instruments employed in signalling being so expensive as to deserve a thorough protection if it can be given), but the fact that cables are always coated with a stout metallic sheating is a peculiar circumstance not found in the lines of land telegraphs, whether overhead or underground, and it is a circumstance which, I wish to point out, renders their complete protection from lightning peculiarly definite and easy.

First, it is clear that risk is run wherever a cable is connected to a land line. I do not suppose this is ever done with the long ocean cables; but for short lengths, across gulfs, &c., I suppose transmission is usually immediate. Even with ocean cables I understand that the land line to the station is often led to the same switchboard as the cable instruments are connected to; and whenever there is any sort of proximity of this kind, a flash received by some distant part of the land line must be liable to spit across some of the terminals, and flick off a bit of itself into the cable and its instruments.

Two lightning switches at least ought to be employed in every such station: one, a coarse one, at the place where the land line enters the building, to eliminate the grosser violence; and another, a fine one, at the mouth of the cable, to filter out the last traces of dangerous disturbance.

A proper mode of connecting one of my protectors to a cable is shown in fig. 14. Here the outside sheath of the cable is used as sole earth, as is, I believe, customary. Another proper mode is to have a subsidiary or local earth; connection being made as in fig. 15.

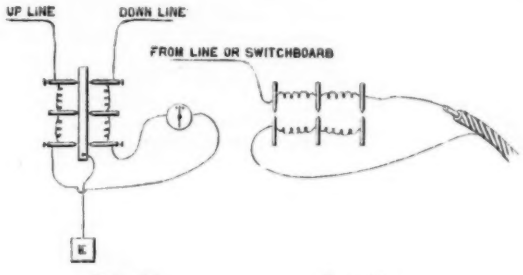


FIG. 13. FIG. 14.

I am not prepared to support one of these in strong preference to the other. The second plan, however, is not to be adopted without the local earth. If there be no local earth, the first is the only proper plan, for it permits disturbances coming down the line to get to the outer sheath of the cable as directly as possible, the interior being protected by impedance; it also permits disturbances surging up the cable sheath, as they may when the shallow shore water is struck by a flash, to get to the line capacity directly, and not to easily enter the cable core.

But now suppose a case where no land line or connection is permitted to come within many yards of the cable station, though I suppose such a plan would be extremely inconvenient; let the cable be connected to nothing but its own instruments—where is the need of a lightning switch then?

The only danger that can occur now is when these instruments are struck direct, either from the roof or walls, or from gas pipes, or from the earth upon which they stand. A filter must therefore be arranged to protect the cable, even in this case. No fragment of cable core exposed ousside its sheath can be considered safe. It would only be quite safe if it could be wholly put inside its metallic sheath and kept there.

But while so carefully contemplating the protection of the cable, why not protect its instruments as well?—for a siphon recorder and an artificial cable are no cheap toys. It can be done perfectly well. Put them all inside the sheath of the cable and they are safe. Of course the sheath of the cable must be enlarged to receive them, but that is easy enough. Use a metal house, and at the point where the cable enters it attach thoroughly its sheathing wires to the house, making a good joint all round, and the thing is done. The cable station is now an expansion of the sheathing, and everything inside it is perfectly safe.

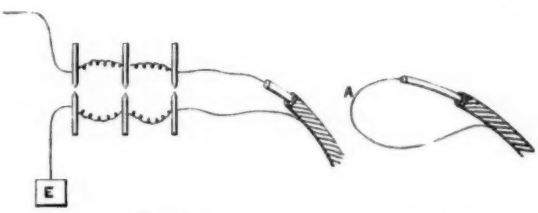


FIG. 15. FIG. 16.

It may be objected that a metal house in hot climates would be a nuisance. Very likely; there may be sufficient practical objections to the plan, but that is for others to judge. However, continuous sheet metal is unnecessary. Wire gauze, even with meshes so large as is used for poultry yards, may serve sufficiently well, if a few stout wires be added to make effective contact with the cable sheathing.

Unless practical difficulties in so casing in a cable station are greater than any I foresee, I cannot help thinking that it would be worth while; because then, even during a thunderstorm, the operators might continue signalling in undisturbed security, instead of having to suspend operations, disconnect the instruments, and short-circuit the cable to its sheath. Slow trails of disturbing current might indeed render signalling difficult or even impossible, but there would be no danger.

Reliance is commonly placed on the short circuit of cable and sheath. If the short circuit is very short indeed, the reliance is fairly justified; but if it be effected by a loop of any size (fig. 16) then there is no absolute security; for a flash striking at A will bifurcate, and part of it rush into the cable. It may be said that that will not matter, because another part of it will be travelling down the outside, and that hence the G.P. between the two pulses (the internal and the external) will not be strained. But there is no guarantee that they will travel at the same rate. There is indeed every certainty that they will not The outside pulse, moreover,

will soon dissipate itself by leakage into sea water, leaving the internal one to work its way out through any weak place it can find. Several hundred volts is a very insignificant potential for such a pulse, but it is not customary to apply several hundred volts to a cable with equanimity.

But if instead of a mere loop we put a thimble or hollow metal vessel over the end of the cable, connecting its sheathing to the walls, and connecting its core to the interior, then no sudden splashes can enter the cable at all, they will keep to the outside and do no harm (fig. 17).

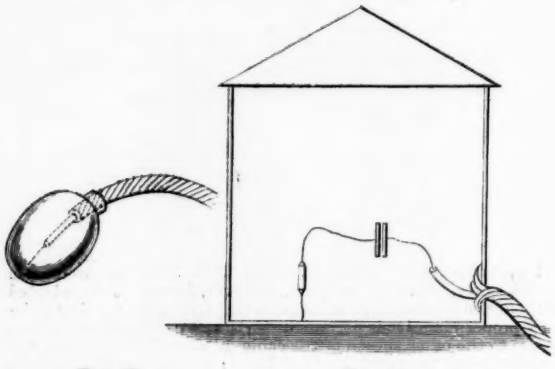


FIG. 17. FIG. 18.

Such a magnified thimble is the proposed metallic or wire-netted cable station; and it is one that has the advantage of never needing to be removed; one which contains instruments and operators, and protects them all alike from dangerous disturbances (fig. 18).

It may be asked whether such a house should depend for its earth entirely on the cable sheathing, or whether a local earth should be provided.

It is not a vital point, but a local earth is to be recommended in order that even the outer sheath of the cable shall not have to carry flashes of exceptional violence, which might unduly heat it. extra earthing the house can do no harm, and may thus occasionally do good. But do not think of sending out to any local earth a wire from the earth terminal of the recorder or any testing instrument inside. The inside of the metal house is their appropriate earth, and no other must be permitted. Again, gas pipes, water pipes, and everything else may be permitted to enter the house, but only on the strict condition that they be effectively united to it at their point of entering—not at some other point. Connecting them or anything else to the house by a mere wire is not a bit of good. The cable, the gas pipes, and every other conductor which penetrate the walls of the house must be *at that place* united to those walls. I have ample experimental, as well as theoretical, grounds for this assertion. No insulated conductor must be allowed to protrude, unless it be enclosed in a metallic sheath connected to the walls, with the distant end of this sheath itself closed. Such an insulated conductor is, of course, the core of the cable itself; the completing closed sheathing being the distant cable station. If that be a mere wooden shanty, disturbances may there enter the cable, and not only do it damage, but derange the signalling power of your instruments at this end also; all your fine protection being no good if not imitated at the far end of the cable.

Since no insulated conductor must, on this plan, be allowed to penetrate the walls, it is manifest that no land line can be permitted to enter a cable station. The land signalling station must be a separate chamber. It need not be a distinct building; it may be under the same roof, but it must be wire-fenced off from the cable compartment, and the messages must be put through non-electrically.

(To be continued.)

LEGAL.

Shangan v. Metropolitan Electric Supply Company.—This was a motion, brought last week before Mr. Justice North, for an interim injunction to restrain the defendant company from continuing to create a nuisance by noise in conducting the operations of building and constructing electric lighting works. The plaintiff was a lodging-house keeper at 11, Manchester Street, Manchester Square. The defendants were constructing an establishment for electric lighting in the rear of the plaintiff's premises. There was evidence on the part of the plaintiff to show that there was an intolerable nuisance and that he was likely to lose his lodgers and have his business affected. The defendants attempted to show that any noise made by their workmen was so trivial that it could not affect any one except a nervous person.

M. Cozens-Hardy, Q.C., and Mr. Cababé appeared for the plaintiff; Mr. Napier Higgins, Q.C., and Mr. Butcher for the company, opposed.

Mr. Justice North said that persons living in a populous district must submit to a certain amount of inconvenience from the acts of their neighbours. He did not see any reason for interfering with what the defendants were doing in the daytime. He was satisfied, however, that what had been done during the two hours between 6 and 8 in the morning was more than a neighbour should reasonably be called on to endure. He therefore granted an injunction limited to that period of time.

Ganz and Co. v. The Edison Electric Light Company.—A remarkable complaint was filed in the United States Circuit Court, New York, on May 3rd. The complaint of Ganz & Co. alleges that in 1886 an agreement was made with the old Edison Electric Light Company, whose obligations have been assumed by the present company, by which the Edison Company was to introduce the Zipernowsky-Deri-Blathy system into the United States, and that $5,000 was paid the complainant on account of the agreement. Ganz & Co. now allege they have discovered that the representations made to them when they transferred the system were false and fraudulent, and their object was to prevent the introduction of the system here. Endeavours have been made, it is further alleged, to create the impression that the alternating current is deadly and unfit for commercial use, and to bring such currents and systems into disrepute. The complaint prays that Ganz & Co. may be released from the agreement and awarded proper damages.

Causton v. National Telephone Company.—This was an action brought in the Westminster County Court last week against the defendant company for alleged damage to premises at 12, Leather Lane, occasioned while fitting up poles. Witnesses were examined as to whether it was necessary to go on the plaintiff's roof to do the work, the engineers of the company denying that it was. Judge Bayley eventually gave judgment for the company, with costs, holding that the company in doing the work had not occasioned the damage complained of.

ELECTRIC LIGHTING IN LONDON.

AUTHORISED WORKS OVER A LARGE AREA.

THE Westminster Electric Supply Corporation has given notice to the London County Council of its intention to lay mains in the following thoroughfares:—Westbourne Street and Place, Caroline Street, Newland Street, Grosvenor Row, Ebury Street, Little Ebury Street, Ebury Square, Bloomfield Place and Terrace, Coleshill Street, Burton Street, Queen Street, Ranelagh Grove, Commercial Road, St. George's Row, Road, and Square, Elizabeth Street, Buckingham Palace Road, Warwick Street, Belgrave Road, Cambridge Street, Stanley Street, Winchester Street, Sutherland Street, Westmoreland Street, Clarendon Street, Gloucester Street, Charlwood Street, Lupus Street, Vauxhall Bridge Road, Tachbrook Street, Hindon Street, Upper Tachbrook Street, Bessborough Street and Gardens, Ponsonby Street, Millbank, Grosvenor Road, Caledonia Street, Claverton Street, Chichester Street, Grosvenor Road, Millbank Row, Millbank Street, Great College Street, Strutton Ground, and Horseferry Road, Westminster.

The Metropolitan Electric Supply Company has also notified its intention to lay mains in Cavendish Square (south and west sides), across Wigmore Street and Henrietta Street, Rathbone Place, Newman Street, Berners Street, Wells Street, Winsley Street, Castle Street east, Market Street and Place, Oxford Market, Great and Little Portland Streets, Margaret Street, Great Castle Street, Princes Street, Holles Street, Old Cavendish Street, Henrietta Street, Chapel Place, Vere Street, Wimpole Street, Stratford Place, James Street, Bird Street, Orchard Street, Portman Square and Street, Old and New Quebec Streets, Montagu Street, Great Cumberland Street, Somerset Street, Edward Street, Lower Seymour Street, Upper and Lower Berkeley Streets, Seymour Street, Bryanston Street, Upper Bryanston Street, Oxford Street (from Duke Street to the Marble Arch), Edgware Road, Cleveland Street, Upper Charlton Street, Charlton Street, Saville Street, York Street, Nassau Street, Cirencester Place, Great and Little Titchfield Streets, Bolsover Street, George Street, Charlotte Street, Duke Street, Portland Place, Mansfield Street, Chandos Street, Harley Street, Devonshire Street, Carberry Street, Weymouth Street, Clipstone Street, New Cavendish Street, Upper Marylebone Street, Queen Anne Street, Langham Street, Foley Street, Ridinghouse Street, Union Street, Mortimer Street, Charles Street, Alfred Street, Baker Street (part of), Barrett Street, Carlisle Street, Cavendish Place, Dean Street, Duchess Street, Gloucester Street (part of), Langham Place, Manchester Square, Marylebone Lane, Old Portland Street, Ogle Street, Titchfield Street, Upper Rathbone Place, Welbeck Street (part of), North Crescent, and Tottenham Court Road (part of).

These notices were brought before the Council at their last meeting, on Tuesday, by the Highways Committee, and were sanctioned on the condition that three days' notice be given to the engineer of the Council before the works in any thoroughfare were commenced; and that certain stipulations as to the laying of the mains should be carried out.

NEW PATENTS—1890.

5996. "Improvements in electric incandescent lamps." W. B. SAYERS. Dated April 21.

6005. "Electric lamp adjuster." G. H. SAYER. Dated April 21.

6032. "Improvements in electric heating apparatus." M. W. DEWEY. Dated April 21. (*Complete.*)

6037. "Improvements in and relating to electric railway vehicles." M. W. DEWEY. Dated April 21. (*Complete.*)

6041. "Improvements relating to the transformation and utilization of electrical energy." M. W. DEWEY. Dated April 22. (*Complete.*)

6082. "Improvements in the means of and apparatus for distributing and collecting electricity for the propulsion of vehicles." J. E. WALLER and E. MANVILLE. Dated April 22.

6083. Improvements in effecting the electric propulsion of tramcars and apparatus therefor." J. GORDON. Dated April 22.

6100. "Improvements in electric machines for covering wire." J. SCOTT and F. E. DAVIS. Dated April 22. (*Complete.*)

6120. "Improvements in and relating to systems of electrical distribution." C. J. KINTNER. Dated April 22. (*Complete.*)

6121. "Improvements in apparatus for the receipt of coin and for permitting the use of telephonic apparatus in exchange therefor." H. H. LAKE. (Communicated by W. Gray and C. Soby, United States). Dated April 22. (*Complete.*)

6124. "Improvements in manholes for underground electric conduits." J. F. MUNSIE. Dated April 22. (*Complete.*)

6125. "Improvements in and relating to underground main and branch conduits for electrical conductors and to feeding devices therefor." J. F. MUNSIE. Dated April 22. (*Complete.*)

6126. "Improvements in electrical signalling apparatus for police service and the like." R. D. RADCLIFFE. Dated April 22. (*Complete.*)

6138. "Improvements in screens or shades for lamps and gas or electric lights." S. CLARKE. Dated April 22.

6156. "An improved electrical switch for the better and more safe means of breaking the continuity of an electrical circuit of high voltage, and again establishing the same." G. SCHULTZ. Dated April 23.

6223. "Improvements in galvanic batteries." M. ANCIZAR. (Communicated by R. Z. Bayon, South America.) Dated April 23.

6236. "An improved storage or tertiary electric battery." A. J. JARMAN. Dated April 24. (*Complete.*)

6267. "Improvements in means for connecting electrical conductors, applicable more especially for connectimg conducting wires or strips to electrodes used in electrolysis, and as a safety device for electrical purposes." J. MARX. Dated April 24.

6326. "Improvements in electricity meters." E. BATAULT. Dated April 25. [Date applied for under Patents Act, 1883, Section 103, 28th September, 1889, being date of application in Switzerland.]

6389. "An electric motor." A. BLATTNER. Dated April 26.

6490. "Electrical clockwork for pendulum time pieces." E. SCHWEIZER. Dated April 28. (*Complete.*)

6493. "Method of electric refrigeration." M. W. DEWEY. Dated April 28. (*Complete.*) [Date applied for under Patents Act, 1883, Section 103, 15th November, 1889, being date of application in United States.]

6524. "An improved process for securing the better adhesion of metals when electrically deposited or coated." W. RYLAND. Dated April 29.

6561. "An improved desk or stand for supplying detachable paper slips whereon telephonic and other messages may be recorded." A. HALLE. Dated April 29.

6569. "Improvements in electrical measuring instruments." H. H. LAKE. (Communicated by E. Weston, United States.) Dated April 29. (*Complete.*)

6581. "An improved method of repairing the carbon filaments of incandescence electric lamps." H. H. LAKE. (Communicated by La Société L'Incandescence Electrique, France.) Dated April 29. (*Complete.*)

6623. "Improvements in switches for controlling electric currents for lamps and other purposes." J. WARDEN and G. SMITH. Dated April 30.

6726. "An electrical timepiece combined with installations for the distribution of electrical energy for lighting and other purposes." F. VON HEFNER-ALTENECK. Dated May 1.

6801. "Improvements in apparatus for testing leakage and insulation of electrical conductors." A. B. HOLMES. Dated May 2.

6811. "Improvements in telephones." W. VOGEL and G. G. CALKINS. Dated May 2. (*Complete.*)

6841, "Improvements in and connected with electrical fuse boxes, switch boxes and similar electrical fittings." C. R. G. SMYTHE and E. PAYNE. Dated May 3.

6865. "Electrical apparatus for automatically stopping the action of pumps when irregularities of working occur or for giving indications thereof." E. HARTMANN. Dated May 3.

6878. "An improved electric alarm device for clocks." R. SCHMITZ. Dated May 3.

CORRESPONDENCE.

Lightning Protectors.

With regard to the question whether existing lightning protectors are perfect instruments, never known to fail, may I ask you to find room for the following information derived from a French official return, kindly handed to me after the meeting of the Inst. E.E. by Prof. Hughes. The particular year for which the return happens to be made is accidental.

Telegraphic Objects belonging to the French Government Damaged by Lightning in 1883.

	Number in Use.	Number Damaged
Posts	1,285,528	954
Insulators	3,619,712	609
Telegraphic lightning guards	27,462	477
Telephonic do.	680	2
Galvanometers	11,456	5
App. à Cadran	691	0
App. Morse	8,641	24
App. Hughes	600	0
App. Baudot	30	0
App. Wheatstone	12	1
App. Meyer	4	0
Sounders	14,057	90
Telephones	921	2

Or, summarising them as number destroyed per 1,000 in use:

Lightning guards	17·4	per thousand per year.
Sounders ...	6·4	" "
Morse instruments	2·8	" "

Perhaps you could also find room for the following quotations from Preece and Sivewright's "Text-book of Telegraphy," Longmans, 1887, pp. 257—9.

"Lightning is the most frequent source of faults upon telegraph circuits in those countries where thunderstorms are rife, and atmospheric electricity is undoubtedly the greatest enemy which those employed in their maintenance have to encounter. . . . . Earth currents are only troublesome at long intervals; but lightning is a constant source of trouble, frequently breaking down the circuits, and sometimes, in spite of all precautions, so damaging the instruments as to render their removal necessary. . . . . Although the dangers liable to arise from lightning have been to a great extent surmounted of recent years, still it cannot be said that a thoroughly efficient form of lightning protector for telegraphic purposes has yet been devised."

Lastly, comparing the diagrams fig. 4 and fig. 8 on your page 559 last week, it must be apparent to anyone, even without special knowledge or experiment, that the latter cannot be worse, and may be better than the former under all possible circumstances.

Oliver J. Lodge.

New Alternating Current Motor.

In your issue of May 3rd there appears a description of a *new* alternating current motor. It may be of interest to note that in my specification, 16,852, 1888, this motor is described in detail, and illustrated, the only difference being that the field magnets there shown are double instead of single.

The results to be obtained from a motor of this class are not, however, very promising; it has the disadvantage of all motors where the total magnetisation is reversed at every alternation, viz., the large size for a given output, and the large output capacity in the dynamo or transformer feeding it.

Thus, to work a motor with an output of about 1 H.P., the feeding generator or transformer must be able to supply about 100 volts at the terminals, and nearly 200 ampères, or the apparent power is more than ten times the real power to be transformed.

Llewelyn B. Atkinson.

May 19th, 1890.

Queen's New Triple-Plate Topler-Holtz Machine.

In your issue of April 11th, 1890, you give a description of a newly-patented Topler-Holtz machine, of

which the second revolving plate is simply a perfectly plain glass plate, without coating or metal buttons, placed behind the fixed plate.

Permit me to tell you this machine is not new. I got one *exactly* like that you gave the description of from T. Robert Voss, of Berlin, in March, 1889.

J. W. Giltay.

Delft, Holland, *May 16th*, 1890.

Accumulator Theories.

In the issue of March 11th I find reprinted a part of a paper read before the electric club here. In a more extensive way you reprinted the criticism of Prof. Carhart. It is in answer of this criticism, which you accepted so easily, that I wrote the article contained in the *Western Electrician* of May 3rd, of which you will receive a copy with this letter. You would oblige me by taking notice of this answer, thus showing your impartiality.

Paul Schoop.

Chicago, *May 2nd*, 1890.

[We have shown our impartiality in a leaderette, but we fear Dr. Schoop will derive but scant satisfaction from our comments.—EDS. ELEC. REV.]

Lighting Arresters.

A passage appears in the editorial note of your last issue which seems to imply that I possess a similar feeling towards the scientific Professor that a certain gifted personage is commonly credited with as having in respect to holy water. I am not in any way thin-skinned, but at the same time you must allow me to say I do not consider it quite fair on you part to make such a charge. As a matter of fact, I have learned from personal acquaintance to regard our scientific professors, as a whole, very highly, not only as men of culture but as having also a high sense of their moral responsibilities. I myself am very fond of scientific research, and I have devoted a very large portion of my leisure time to trying to solve problems associated with matter and force; but nevertheless I do not think that physical science should be placed on a pedestal to be worshipped. Physical research is really but little more than scraping the very outside cuticle of matter, and unless physical research is pursued from some higher motive than a mere love of scraping, then scientific workers, among whom I hope I may be allowed to include myself, are only superior hewers of wood and drawers of water. The man who spends his life either solely in the laboratory, or who devotes the whole of his time to rendering himself a more and more perfect calculating machine, is liable to become as mentally contracted and bigoted as the monk who never leaves his cell, or the man who spends his life among the cloisters of an abbey.

Some of our scientists who consider themselves to be in the very foremost van of human progress seem to me to have become so buried and blinded in the dust they spend their lives in scraping, that they remind me of tailors or dressmakers who are so engrossed in their undoubtedly useful callings (if, indeed, there be any such), who, having obtained permission to look on some State function, perceive on all sides the triumphs of the dressmaker and the successes of the tailor, but have no eyes to see that it is the graceful forms and the living souls of the wearers which imparts whatever grace and real beauty their work possesses. To make solid advances, men are required who can look at matter from the broad angle of vision of a whole man, and not simply from the magnified narrow angle of vision of the specialist, who only sees one thing at a time, and each thing detached from the rest, and seems unable to take into account the mutual influence and bearing on one another of the composite forces which govern matter.

For real scientific progress, men having some poetry in their souls are necessary—men who can enter into the spirit which made man, in the earlier days of the world, see nymphs and goddesses in the fountains and the rivers, and spiritual direction in all the operations of Nature, and who, feeling his powerlessness and littleness in the presence of the mysteries that surrounded him, knelt down and worshipped that glorious manifestation of beneficence and power, the sun, as seen in an eastern climate.

Our greatest scientists of the past, such as Newton, Davy, Faraday, Maxwell, were all of them more or less complete men who did not regard man as being only a mass of matter and force developed by a process of evolution set going by a property of matter. The leopard cannot change his spots, and neither can man change his nature. Man ever will be man, do what he may; and one of the most distinguishing features of man is that he is, in spite of himself, a religious animal who must worship something, and the conceited, narrow-minded man who arrogates to himself the claim to be considered a man of advanced ideas, sets up a wooden god of his own, which he most devoutly worships; and he calls those of his fellow creatures benighted fools who refuse to do likewise.

S. Alfred Varley.

May 20th, 1890.

Electrical Tramway Systems.

We have read Mr. Allsop's letter in your last issue, and have obtained copies of the specifications to which he refers.

We observe that Mr. Allsop finds it difficult to see any new points in our system, and we are not surprised at this, if, as would appear from his letter, and indeed from his specification, Mr. Allsop attaches no importance to mechanical details, which he thinks may be intrusted to any mechanic.

In our opinion, and, we would venture to say, in the opinion of engineers at large, a successful invention is not so much dependent on a happy idea as on the careful consideration and working out of the many details essential to enable such an idea to be put into a practical working form.

It is to these essential details that we have devoted our attention and, notwithstanding Mr. Allsop's opinion to the contrary, we still think that our system is very far from being identical with that which he proposes.

It is unnecessary to enter into a lengthy controversy in your columns in regard to the differences between Mr. Allsop's system and our own, and, so far as your readers are concerned, their interest will naturally be confined to an examination of the practical merits of the system, and the relative merits of our respective claims can have no bearing on this side of the subject.

I. Edward Waller.
E. Manville.

May 20th, 1890.

Re Ozone.

Referring to your report of Mr. Fahrig's process of making ozone in commercial quantities in your last issue, I cannot understand upon what grounds you base your opinion "that there is something wrong with the process;" anyway it is quite erroneous, and I think entirely uncalled for. As manager of the works, and in Mr. Fahrig's absence, this reflects upon me, hence this contradiction. The other inaccuracies I will pass over except to ask you to note, instead of 10 ampères, it should read 100 ampères, and for stirilisers read dialisers.

Jno. C. Lawson.

May 20th, 1890.

[We have no doubt that our correspondent believes he has virtually settled the question of the production of ozone, but we may remind him that a simple denial of what we gave, not merely as our own opinion but the generally accepted one, does not carry the conviction with it that we have been labouring under a wrong impression. There is here a good opportunity for Mr. Lawson to explain the Fahrig process in his own way, and give any data if he can of the commercial results of the operations he is carrying on.—EDS. ELEC. REV.]